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Rosen, S. (1988) Bio-Workshop 2.
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AIM | What are cells?

1

The Great Pyramids of Egypt are made of stone blocks. Buildings are put together with bricks. Birds build their nests with grass and twigs. Everything is made up of smaller parts. . . . EVEN YOU!

Living things are made up of small parts called *cells*. The cell is the basic unit of structure in all living things. Because all living things are made up of cells, cells are often called "the building blocks of life."

Some organisms, like bacteria, are made up of only one cell. Larger organisms have many more cells. A person, for example, is made up of *trillions* of cells. Can you imagine how many cells a whale must have?

Cells come in many sizes. Most are *microscopic* [my kruh SKOP ik]. Some cells, however, can be seen easily. For example, a chicken's egg is a single cell. Do you need a microscope to see a chicken's egg?

Cells also come in many shapes. For example, a muscle cell has a different shape than a nerve cell. Skin cells have a different shape than fat cells.

As you see, there are many differences among cells. But cells also have many things in common. For example, all cells are made up of a *living* material called *protoplasm* (PRO tuh plaz um). Protoplasm is mostly water. But protoplasm also contains dissolved salts and many *organic* (carbon) compounds. The term *organic* means "life."

A cell is a living thing. It carries out all the life functions. For example, a cell takes in *nutrients* and *oxygen*. It gives off *waste* products. Cells use and release *energy*. *Movement* takes place inside a cell. And, cells also *reproduce*.

Cells are made up of many parts. Each cell part has a special job to do. These parts work together to keep the cell functioning properly.

In this aim, you will learn about some of these cell parts. You will also learn how animal cells are different from plant cells.

A TYPICAL ANIMAL CELL

Figure A shows seven cell parts. These parts are found in almost every animal cell. The name of each cell part is listed below.

- cell membrane (SELL MEM brane)
- cytoplasm (SY tuh plaz um)
- nucleus (NEW klee us)
- nuclear (NEW klee ar) membrane
- mitochondria (my tuh KON dree uh)
- ribosomes (RY buh soamz)
- endoplasmic reticulum (EN doh plaz mik rih TIK yoo lum)

Each cell part is described below the diagram. As you read each description,

- identify the cell part in the diagram, then
- write the name of that part on the proper line in the diagram.

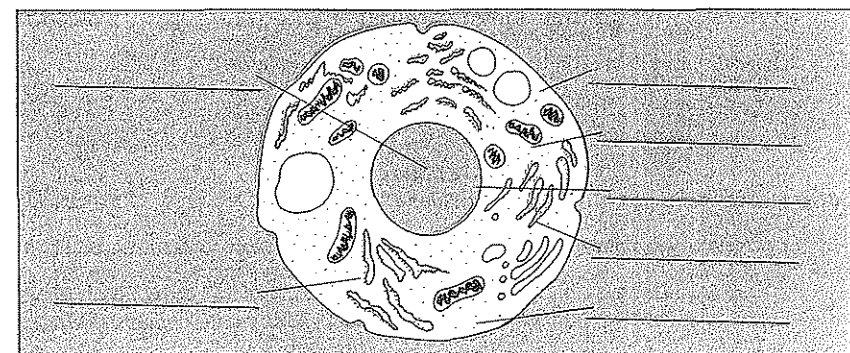


Figure A A typical animal cell.

CELL MEMBRANE

A thin covering that surrounds the cell. The cell membrane

- a) protects the cell,
- b) helps give the cell its shape,
- c) allows materials to enter and leave the cell, and
- d) helps keep the cell material together.

CYTOPLASM

A thick fluid that fills most of the inside of the cell. Cytoplasm helps give a cell its shape. Most of the life functions take place within the cytoplasm.

NUCLEUS

A ball-shaped structure. It is often found near the center of the cell. The nucleus is the "boss" of the cell. It controls all of the cell's activities. The nucleus is especially important during reproduction.

NUCLEAR MEMBRANE	A thin covering that surrounds the nucleus. The nuclear membrane controls the passage of materials into and out of the nucleus. It also gives the nucleus its shape.
MITOCHONDRIA	Mitochondria are rod-shaped. They are the "power houses" of the cell. Mitochondria store and release the energy the cell needs to carry out the life functions.
ENDOPLASMIC RETICULUM	A network of channels. The endoplasmic reticulum is like a series of "roadways." They are used for moving materials within the cell.
RIBOSOMES	Tiny grainlike structures. The ribosomes make and store protein. Most ribosomes are found on the endoplasmic reticulum. Some, however, move freely within the cytoplasm.

Answer the following questions about cells.

8. The parts of the cell that you have labeled are all made up of "living" material.
What is the living material of the cell called? _____
9. Where do most of the life functions take place within a cell? _____
10. a) Does each part of the cell work alone? _____
b) Explain your answer. _____

A WORD ABOUT PLANT CELLS

Plant cells and animal cells are similar. But they are not exactly the same.

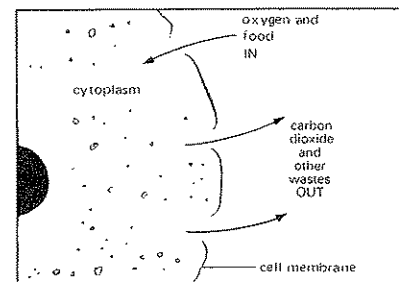
Plant cells have two parts that animal cells do not have. These parts are: a cell wall and chloroplasts.

CELL WALL	The cell wall surrounds the cell membrane of the plant cells. The cell wall is made of a nonliving material called cellulose. The cell wall gives a plant its stiffness. It helps a plant to stand erect.
CHLOROPLASTS	Chloroplasts are spread throughout the cytoplasm of plant cells. The chloroplasts contain a green substance called chlorophyll. Green plants need chlorophyll (along with carbon dioxide and light energy) to make their own food. Chlorophyll is found mostly in leaf cells.

THE "INS AND OUTS" OF THE CELL MEMBRANE

Substances must be able to get into and out of a cell in order for the cell to do its job. The passage of these materials takes place through the cell membrane. The nucleus, or "cell boss," controls the passage of these materials.

A cell membrane has tiny holes. Liquids carrying dissolved substances pass through these holes in a process called osmosis [ahs MOH sis]. Osmosis is very "choosy." It allows only certain substances to move into the cell. And only certain substances may move out of the cell. For example, dissolved nutrients and oxygen can move only into the cell. Dissolved wastes, such as carbon dioxide, can move only out of the cell.



What might happen if the amounts of substances entering and leaving the cell were not controlled? It depends. . . . The cell might a) swell or

b) shrink, or

c) become poisoned.

- I. Think about each of the following possibilities. Write your answer in the space provided.

What might happen if:

1. too much liquid moved into a cell? _____
2. too much liquid moved out of a cell? _____
3. too little liquid moves into a cell? _____
4. too much liquid moves out of a cell? _____
5. too little waste moves out of a cell? _____

- II. Circle the letter of the correct answer.

6. What kinds of materials enter a cell?
a) materials the cell needs b) waste materials
7. What kinds of materials leave a cell?
a) materials the cell needs b) waste materials

COMPLETING SENTENCES Complete the sentences with the words below.

salts	cells	cell wall
erect	shape	life function
size	nucleus	organic compounds
osmosis	food-making	protoplasm
water	chloroplasts	

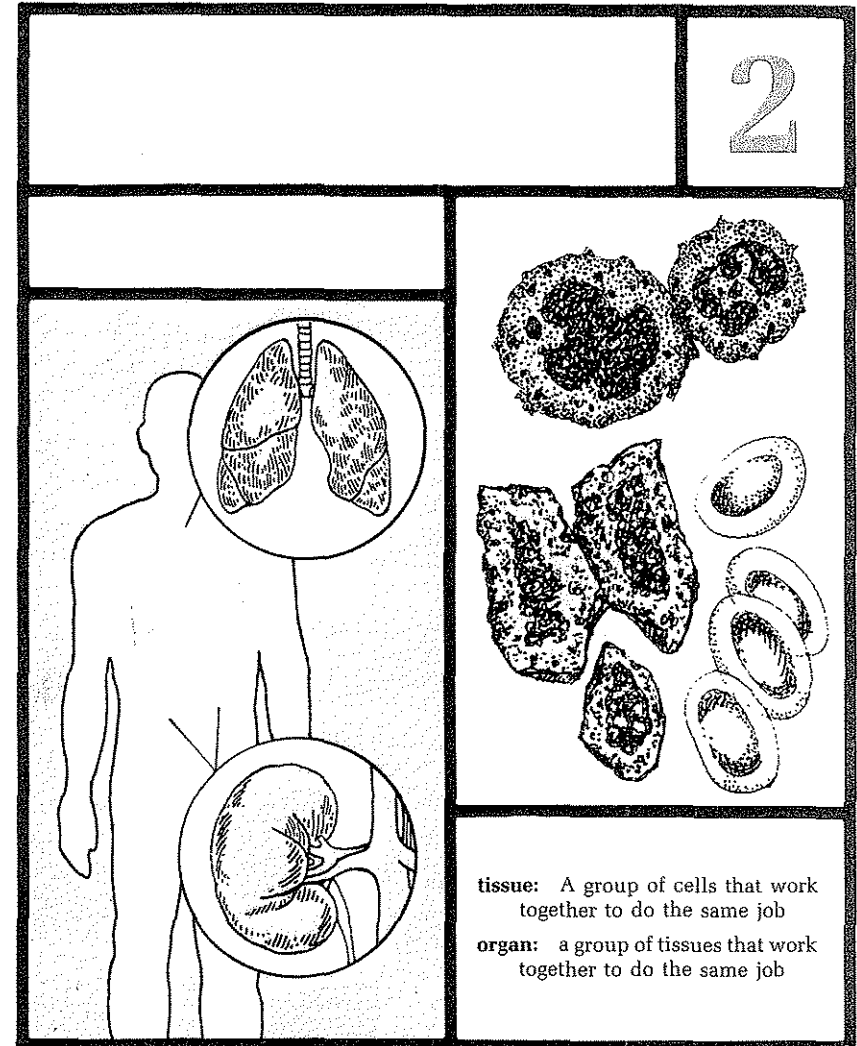
- The "building blocks" of living things are _____.
- Cells vary in _____ and _____.
- A cell carries out every _____.
- The living material of a cell is called _____.
- Protoplasm is mostly _____, _____, and _____.
- Two cell parts that are found only in plant cells are a _____ and _____.
- Chloroplasts are needed for _____ in plants.
- The cell wall helps a plant stand _____.
- Substances move into and out of a cell through a process called _____.
- The passage of substances into and out of a cell takes place through the _____.

REACHING OUT On a separate piece of paper, draw a picture of an animal cell. Try to do it from memory. Be sure to include and label each of the parts listed below.

- cell membrane
- cytoplasm
- nucleus
- nuclear membrane
- mitochondria
- ribosomes
- endoplasmic reticulum

WHAT ARE TISSUES AND ORGANS?

2



AIM | What are tissues and organs?

2

A car has many parts. Each part does a special job. But all the parts must work together to keep the car running well.

In some ways, your body is like a car. Your body has many parts. These parts work together to keep you running well.

As you know, your body is made up of trillions of cells. These cells are alike in certain key ways. Yet there are some important differences. Some of your cells do specific jobs. They are *specialized* [SPESH uh lized].

The job of a specialized cell can only be done by that kind of cell. No other kind of cell can do that job. For example, only nerve cells can send and receive messages. Only muscle cells can produce movement.

TISSUES

Specialized cells are similar in size and shape. But, to work properly, these cells must work together. They must "team up." They form specialized groups of cells called tissues. A tissue is a group of similar cells that work together to perform a specific function.

Humans are made of many kinds of tissues. They include *epithelial* [EP ih thee lee ul] tissue, *nerve tissue*, *connective tissue*, *muscle tissue*, *blood tissue*, and *reproductive tissue*.

ORGANS

Tissues do a better job than cells. But even tissues cannot work alone. Tissues must also "team up." Similar tissues that join together to do a specific job are called organs.

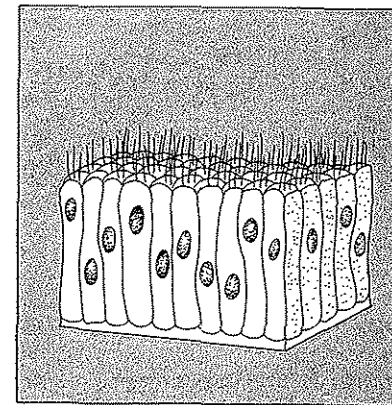
Your body has many organs. Your heart is an organ. It pumps blood throughout your body. The heart is an organ of circulation. Your nose, windpipe, and lungs are organs, too. These organs are used for respiration. You also have sense organs. Sense organs tell you "what's happening"—both inside and outside your body.

FORMING TISSUES AND ORGANS

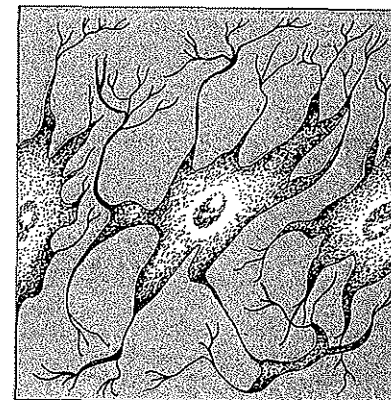
Use what you have read so far to answer the questions below.

1. What combine to form tissues? _____
2. Name six kinds of tissue found in the human body. _____, _____, _____, _____, _____, and _____.
3. What combine to form organs? _____

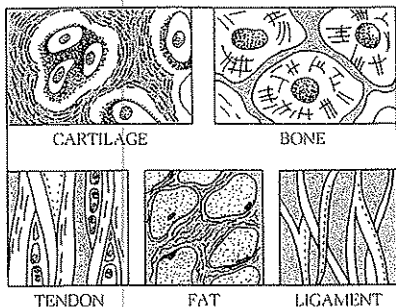
HUMAN TISSUES AND THEIR SPECIAL JOBS



EPITHELIAL TISSUE covers other tissue. Skin is made of epithelial tissue. Epithelial tissue covers organs both inside and outside your body. It helps keep out germs, and protects you from injury and drying.

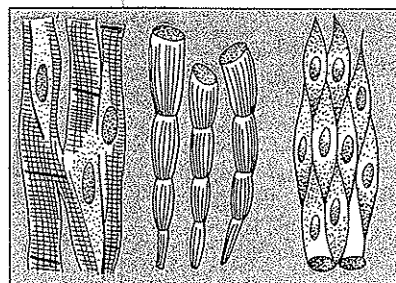


NERVE TISSUE sends and receives messages. Nerve tissue allows us to respond to *stimuli* [STIM yuh lie], or changes in our surroundings. Nerve tissue responds to changes both inside and outside the body.

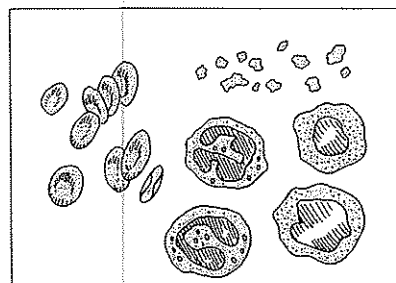


CONNECTIVE TISSUE supports the body and holds it together. Connective tissue also helps to protect the body.

Bone, cartilage [KAR tih lij], fat, tendons, and ligaments [LIG uh ments], are all examples of connective tissue.



MUSCLE TISSUE makes movement possible.



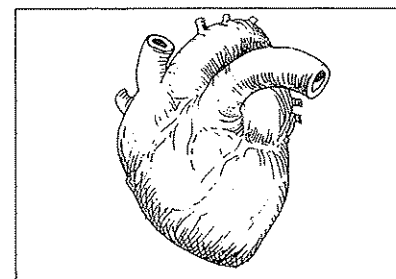
BLOOD TISSUE carries oxygen, digested food, and important chemicals to all parts of the body. Blood tissue also carries away wastes. Special white blood cells help to fight infections. Blood tissue is mostly liquid.

REPRODUCTIVE TISSUE makes it possible to produce offspring.

MORE ABOUT TISSUES AND ORGANS

Your body has many organs. An organ is made mostly of just one kind of tissue. But an organ has other tissues, also.

■ For example, your **HEART** is an organ. It pumps blood throughout your body. The heart is made mostly of muscle tissue. But it is also made of



- a) blood tissue,
- b) nerve tissue, and
- c) fat tissue.

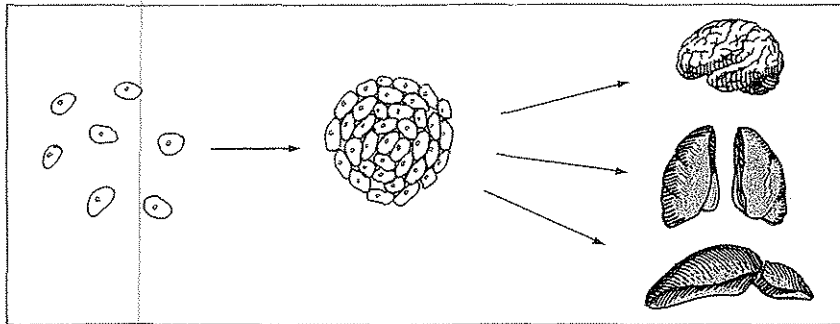
The chart below lists several organs and their jobs. It also lists some of the tissues that make up each organ.

SOME ORGANS OF THE HUMAN BODY

ORGANS	JOB	TISSUES
HEART	to pump blood throughout the body	mostly muscle; also blood, nerve, and fat
STOMACH	works with mouth, esophagus [ee SOF uh gus], or food pipe, and small intestine to digest food	muscle, fat, nerve, blood, and other tissues
SKIN	covers and protects the body; helps get rid of salts, water, heat, and a small amount of urea	mostly epithelial; also blood, nerve, and other tissues
BRAIN and SPINAL CORD	the brain is the organ of thinking; the brain and spinal cord send and receive messages	mostly nerve; also blood, connective, and other tissues
EARS, EYES, NOSE, TONGUE, and SKIN	sense organs; tell what is happening around you	nerve, muscle, blood, and other tissues

WHAT DO THE PICTURES SHOW?

Use the information in the chart on page 11 to answer the questions about the pictures below.

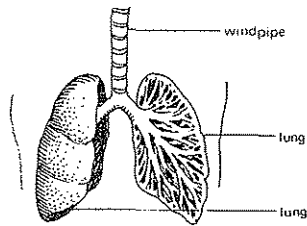


SINGLE CELLS → TISSUES → ORGANS

1. What combine to form tissues? _____
2. What combine to form organs? _____

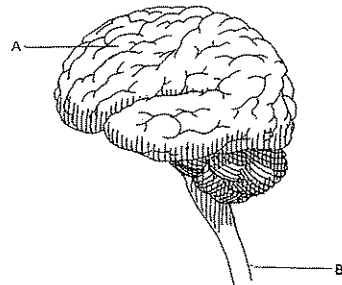
The lungs and windpipe are organs used for breathing.

3. How many lungs does a healthy person have? _____
4. What three waste products do the lungs get rid of? _____



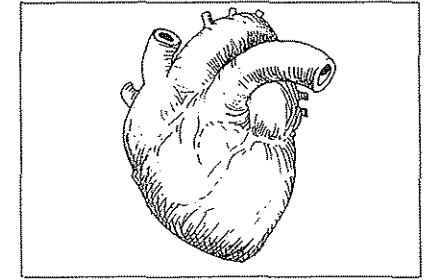
The two organs shown here are made mostly of nerve tissue.

5. What is the name of organ A? _____
6. What is the name of organ B? _____



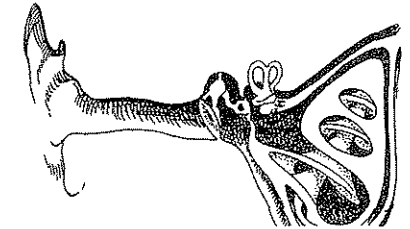
This organ acts as a pump.

7. What is the name of this organ? _____
8. What three kinds of tissue is this organ made of? _____



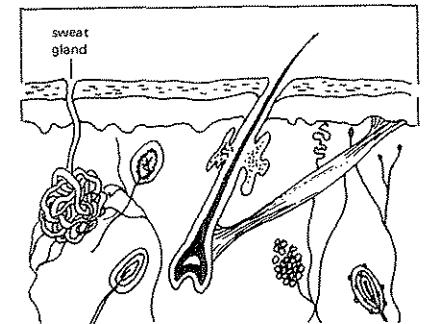
The ear is one of five sense organs. Sound causes your eardrum and the tiny bones inside your ear to move. Messages are then sent to your brain and you hear.

9. What sense organ lets us see? _____
10. What sense organ lets us smell? _____



Your skin is the largest organ in your body. Sweat glands in the skin get rid of waste products.

11. What three waste products do sweat glands get rid of? _____
12. What is the waste product that you can taste that leaves through the skin? _____



MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--------------------------------|---|
| 1. _____ blood tissue | a) organ of circulation |
| 2. _____ connective tissue | b) covers other tissues |
| 3. _____ epithelial | c) made mostly of nerve tissue |
| 4. _____ white blood cells | d) carries oxygen and wastes |
| 5. _____ sense organs | e) produce movement |
| 6. _____ muscle tissue | f) bone, fat, tendons, ligaments, and cartilage |
| 7. _____ brain and spinal cord | g) organ of digestion |
| 8. _____ stomach | h) ears, eyes, nose, skin, and tongue |
| 9. _____ lungs | i) organs of respiration |
| 10. _____ heart | j) fight infection |

REACHING OUT Plants have organs too. Plant organs are just as important to a plant as your organs are to you. Figure A shows four important plant organs. Use the illustration to answer the questions.

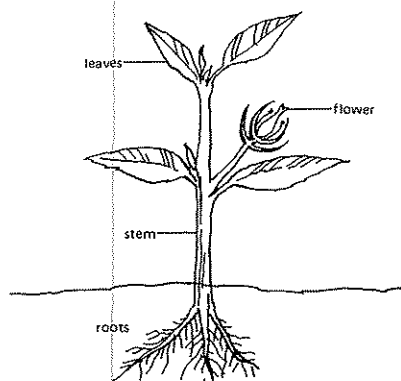


Figure A

- Which organ holds up the plant?

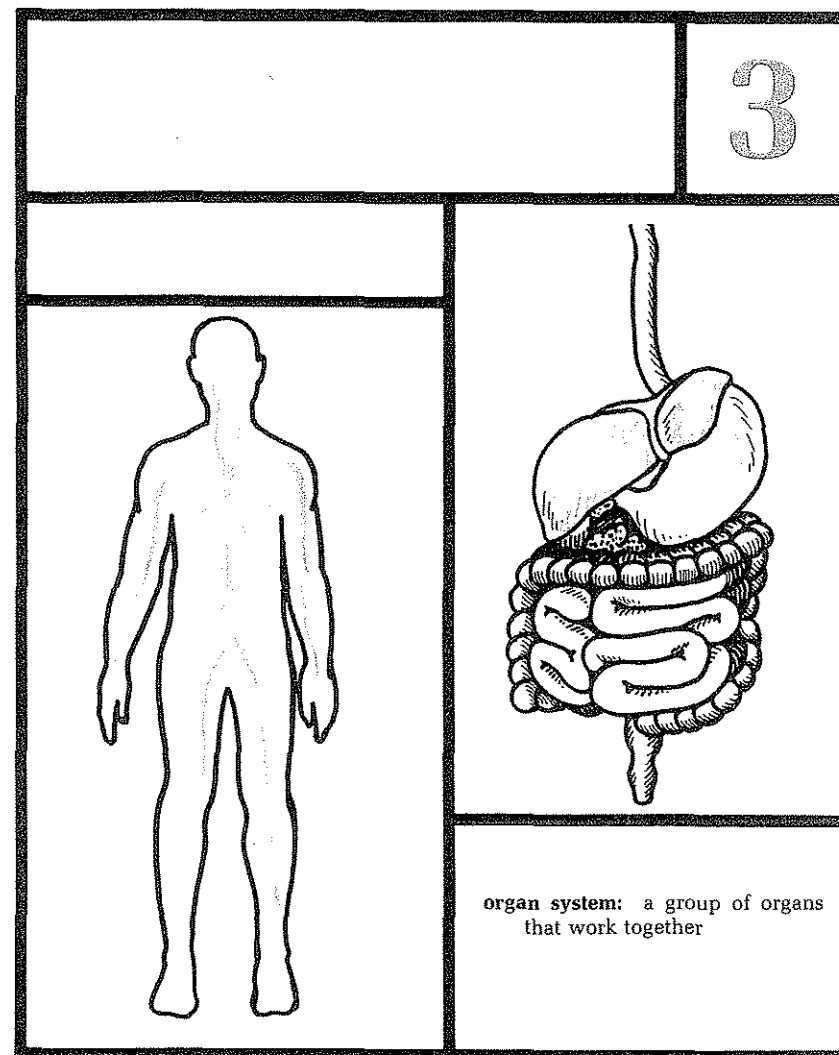
- What part do plant cells have that help to hold up a plant? (Hint: Think back to what you learned in Aim 1.) _____
- In what plant organ is food made?

- What cell part of plant cells makes food-making possible? (Think back to Aim 1 again.) _____

- Which plant organ is needed for reproduction? _____
- Which plant organ takes in water and dissolved minerals? _____

WHAT IS AN ORGAN SYSTEM?

3



organ system: a group of organs that work together

AIM | What is an organ system?

3

Individual body cells are very important to life. But these cells do not work alone. They need help.

As you know, similar cells join together to form tissues. Tissues, in turn, form organs. Organs do important jobs. But even organs do not work alone.

Usually, several organs work together to carry out a specific life function. A group of organs that work together to do a specific job is called an *organ system*.

Each organ in an organ system has a specific job to do. For example, the mouth, the food pipe (esophagus), the stomach, and the pancreas [pan KREE us] are organs of the *digestive* [die JES tiv] system. The digestive system changes food to a form the body can use.

Food is chewed up and wet down in the mouth. After the food is swallowed, it passes through the *food pipe* (esophagus) and into the stomach. The stomach begins protein digestion. The pancreas makes digestive chemicals. These chemicals help to break down the food you eat.

The human body has several organ systems. Each organ system works to carry out one of the life functions.

Look at the chart on the next page. As you look at this chart, you will notice that some organs are part of more than one organ system.

For example:

- a) The liver is part of the digestive system. The liver is also part of the excretory [EK skruh tor ee] system. The excretory system gets rid of cell wastes.
- b) The mouth is part of the respiratory [RES puh ruh tor ee] system. The respiratory (breathing) system brings oxygen into the body. It also carries out carbon dioxide. As you already know, the mouth is part of the digestive system, too.

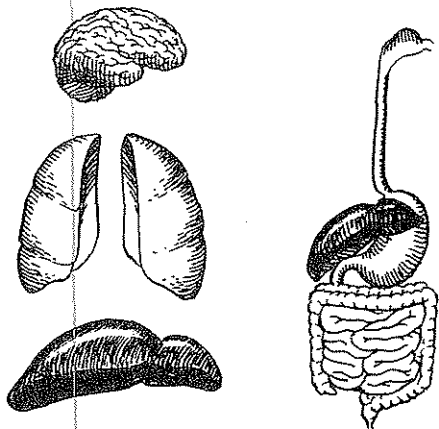
Your body has several organ systems. These systems all work together. And, together they form a living organism—YOU!

THE ORGAN SYSTEMS AND THEIR ORGANS

Organ System	Organs
Digestive system	mouth food pipe stomach small intestine large intestine liver pancreas
Respiratory system	nose and mouth windpipe lungs(2)
Circulatory system	heart blood vessels
Nervous system	brain spinal cord nerves
Excretory system	kidneys(2) skin lungs liver large intestine
Reproductive system	ovaries(2) (female) testes(2) (male)
Endocrine system	thyroid gland pituitary gland thymus Islets of Langerhans ovaries (female) testes (male)

LABEL THE PICTURE

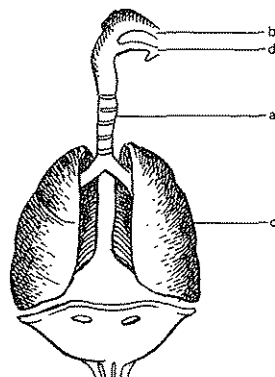
These pictures show what you've just read about: organs, organism, and organ system. Which is which? Write the correct label on the line under each picture.



FIND THE ORGANS

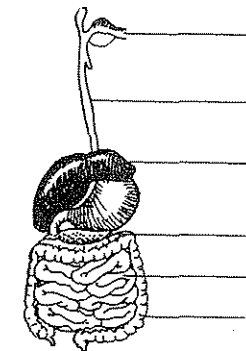
Each of the pictures below and on the next two pages shows an organ system. The organs of each system are listed next to each picture. In the space next to each organ name, write the correct letter from the picture.

lungs _____
windpipe _____
mouth _____
nose _____



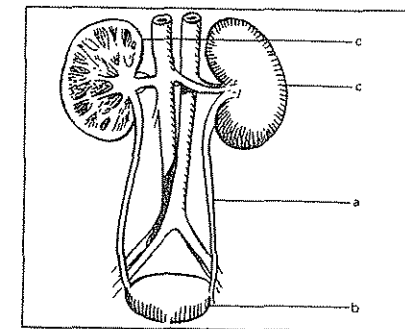
RESPIRATORY SYSTEM

large intestine _____
small intestine _____
mouth _____
liver _____
pancreas (below stomach) _____



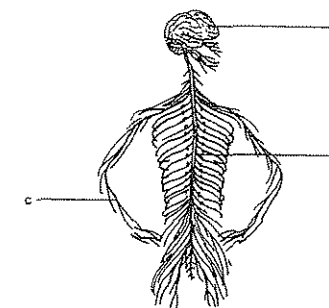
DIGESTIVE SYSTEM

kidneys _____
kidney tube _____
bladder _____



KIDNEY SYSTEM

spinal cord _____
brain _____
branching nerves _____



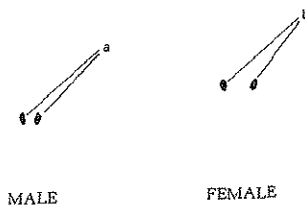
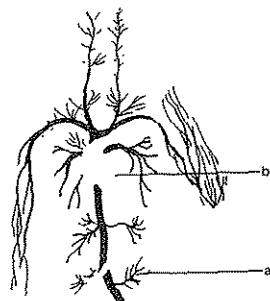
NERVOUS SYSTEM

heart _____
blood vessels _____

CIRCULATORY SYSTEM

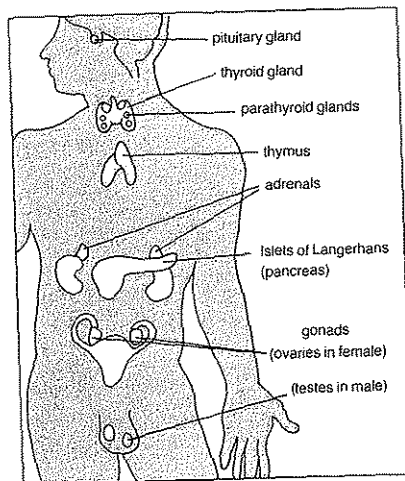
ovaries _____
testes _____

REPRODUCTIVE SYSTEM



The organs shown in the diagram on the right are *glands*. Glands make up the endocrine system. Glands make chemicals the body needs to carry out the life functions.

1. What organ system do these organs belong to? _____
2. What organs of this organ system does a female have that a male does not have? _____
3. What organs of this system does a male have that a female does not have? _____



COMPLETE THE CHART

The organs of the organ systems are listed in the first column of the chart. Make a check (✓) in any of the other columns if the organ belongs to any of the systems. Remember: An organ may belong to more than one system. If you need help, look back a few pages.

ORGANS	ORGAN SYSTEMS						
	digestive	respiratory	excretory	reproductive	circulatory	nervous	endocrine
1. large intestine							
2. bladder							
3. brain							
4. ovaries							
5. nose							
6. pancreas							
7. liver							
8. blood vessels							
9. kidneys							
10. spinal cord							
11. thyroid gland							
12. lungs							
13. heart							
14. small intestine							
15. kidney tube							
16. mouth							
17. nerves							
18. windpipe							
19. food pipe							
20. skin							
21. thymus							
22. testes							

COMPLETING SENTENCES

Complete the sentences with the words below. One word may be used three times. Another word is used twice.

respiratory
organ system
organ

tissues
circulatory
more than one
cells

excretory
digestive
organism

1. Living things are made of one or more _____.
2. Cells grouped together form _____.
3. Tissues working together make up an _____.
4. Two or more organs working together make up an _____.
5. Several systems make up an _____.
6. Sometimes, one organ may work in _____ system.
7. The liver is part of the _____ system. It is also part of the _____ system.
8. The large intestine is part of the _____ system. It is also part of the _____ system.
9. The heart is part of the _____ system.
10. The lungs are part of the _____ system. The lungs are also part of the _____ system.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|----------------------|---|
| 1. _____ kidney | a) organ of the nervous system |
| 2. _____ ovaries | b) organ of the excretory system |
| 3. _____ spinal cord | c) group of organs working together |
| 4. _____ system | d) part of digestive and respiratory systems |
| 5. _____ mouth | e) part of the reproductive and endocrine systems |

TRUE OR FALSE

Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ One organ usually works alone.
2. _____ A system has at least two organs.
3. _____ Every organism has organs. (Think about this one carefully!)
4. _____ An organ can belong to more than one system.
5. _____ The liver belongs to only one system.
6. _____ The stomach belongs to only one system.
7. _____ Tissues, organs, and systems are made of cells.
8. _____ Different organ systems help each other.

WORD SEARCH

The words in this list are hidden within the groups of letters. Try to find each word. When you find it, draw a line around the word. The spelling may go in any direction.

SYSTEM
ORGANISM
MOUTH
BLADDER
OVARIES
TESTES

S	L	A	R	E	N	I	M	L	E
M	T	G	M	O	I	B	S	L	S
I	P	A	N	V	L	S	I	S	T
M	R	L	M	A	E	Y	N	G	N
E	O	L	D	R	E	S	A	A	E
L	T	D	O	I	R	T	G	J	I
S	E	T	U	E	E	E	R	M	R
R	I	R	T	S	P	M	O	Y	T
S	N	Q	T	E	E	U	U	O	U
T	S	E	V	I	T	A	M	I	N
L	S	S	E	H	D	R	M	O	E
M	P	H	V	S	A	Y	E	L	P

KEEPING UP WITH SCIENCE



Did you ever see a third-degree burn? Parts of the skin, and even deeper tissue, are burned away. As a result, the body loses fluids. The chances of infection are very great. The victim goes into shock. If a major part of the body is badly burned, the victim usually dies. Every year, in the United States alone, fire kills about 10,000 persons and injures 140,000 others.

Doctors know that a burn victim has a better chance to live if the burn is kept covered. A heavy layer of vasoline covered with bandage is often used. But usually it doesn't help much.

Skin grafts from the burn victim's own body are best. But often there is too little unburned skin left. Skin from other people (donors) and from pigs have been tried. But the burn victim usually rejects such "foreign" skin. It "fluffs off" soon after it is put on.

Doctors have long hoped for an effective artificial skin. That hope seems to

have been answered. Scientists at the Massachusetts Institute of Technology announced that they have developed an artificial skin that works. This skin is made of two animal protein tissues. Powdered shark cartilage is dissolved in liquified collagen from cowhide. The mixture is poured into a pan and then freeze-dried. It becomes a light, white, and porous film or "skin."

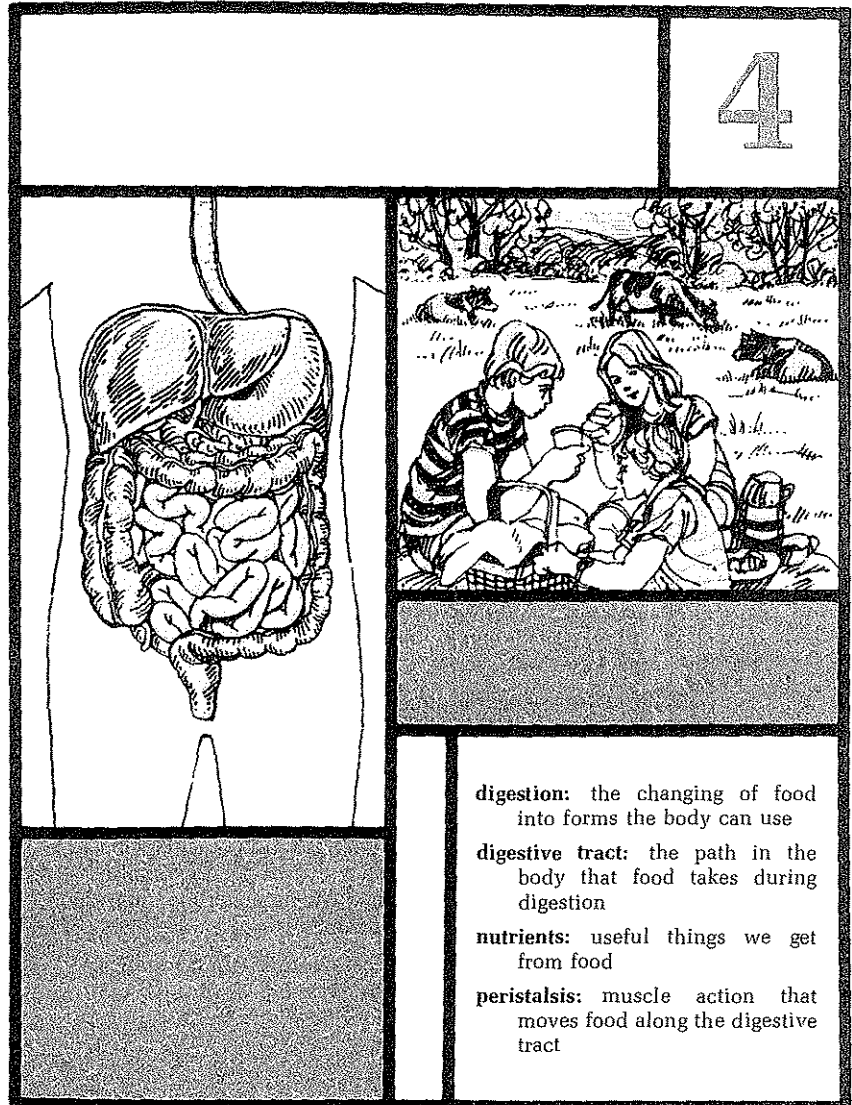
The new skin has been tried on several burn victims. They had deep burns covering 50 to 90 per cent of their bodies. The results were very encouraging. None of the victims rejected the artificial skin. It stayed on until the body grew its own new skin.

Production of this artificial skin is very slow in the experimental laboratory. But it is expected to be speeded up greatly in the hands of a commercial laboratory.

Soon all victims of severe burns will have a better chance of recovering than was ever thought possible.

HOW IS FOOD DIGESTED?

4



digestion: the changing of food into forms the body can use

digestive tract: the path in the body that food takes during digestion

nutrients: useful things we get from food

peristalsis: muscle action that moves food along the digestive tract

AIM | How is food digested?

4

People, like all living things, need food. Food gives us the nutrients [NEW tree ents] our bodies need. It also gives us energy. Energy is needed to carry out the life functions.

Our bodies cannot use the nutrients or energy in food unless the food is changed. The changing of food into a form the body can use is called *digestion* [di JES chun].

WHAT DOES DIGESTION DO?

a) Digestion *dissolves* food. It changes solid food to a liquid.

b) Digestion also changes the chemicals of food. It makes food molecules smaller.

WHERE DOES DIGESTION TAKE PLACE?

Digestion takes place in the digestive tract. The digestive tract is a long, curving tube in your body. If stretched out, the digestive tract would be more than 9 meters (30 feet) long.

WHAT ARE THE PARTS OF THE DIGESTIVE TRACT?

The parts of the digestive tract are: the *mouth*, the *esophagus* (food pipe), the *stomach*, the *small intestine* [in TES tin], and the *large intestine*.

There are many glands along the digestive tract. They are called *digestive glands*. These glands make special chemicals called *enzymes* [EN zyms]. Enzymes help break down food. You will learn more about digestive glands and enzymes in the next Aim.

The digestive tract has two openings to the outside. One opening is the *mouth*. Food enters the body through the mouth. The other opening is the *anus* [AY nus]. Waste materials (undigested food) leave the body through the anus.

Digestion is a step-by-step process. It does not take place quickly. It takes food from one to two days to pass through the entire digestive tract.

WHAT THE PARTS OF THE DIGESTIVE TRACT DO

Read the descriptions below to find out what happens to food as it moves through the digestive tract.

↓
MOUTH

1. Food enters the body through the *mouth*. Digestion begins here.
 - The *teeth* break food into smaller pieces.
 - *Saliva* moistens the food.
 - The chemical *breakdown of starch* starts in the mouth.

↓
ESOPHAGUS

2. When you swallow, food passes into the *esophagus*.
 - Food passes through the esophagus and into the stomach.

↓
STOMACH

3. What happens to food in the stomach?
 - Some *protein digestion* takes place here.
 - Partially digested food then moves to the small intestine.

↓
SMALL
INTESTINE

4. Most digestion takes place in the small intestine.
 - The small intestine is also where *all* digestion is *completed*.
 - Undigested food (waste) then passes into the large intestine.

↓
LARGE
INTESTINE

5. Undigested food (waste) is not used by the body.
 - The large intestine stores and *eliminates* undigested food as *solid waste*.

↓
ANUS

6. Solid waste is passed out of the body through the anus.
 - NOTE: The anus is not a digestive organ.

FOLLOWING THE PATH OF FOOD

Figure A shows food passing through the digestive tract. Study the drawing. Then answer the questions below.

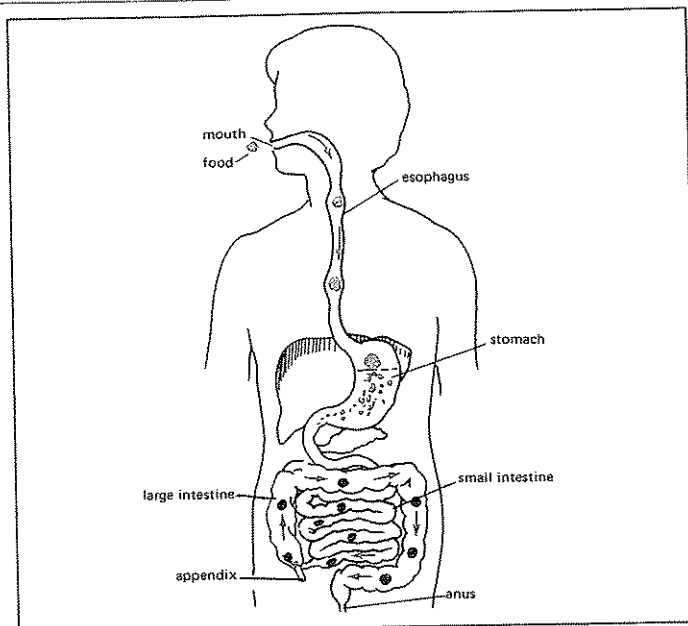


Figure A

- Name the parts of the digestive tract that food passes through in order. (Do not include the anus.) _____, _____, _____, _____, and _____.
- The digestive tract has two openings to the outside of the body.
 - They are the _____ and the _____.
 - Food enters the body through the _____.
 - Waste materials leave the body through the _____.
- What do we call the chemicals that aid digestion? _____
 - What special organs make these chemicals? _____
- Where does digestion start? _____
 - Where does most digestion take place? _____

COMPLETING SENTENCES

Complete the sentences with the words below. Three words will be used twice.

esophagus
completed
digestive tract
large intestine

stomach
dissolves
teeth
mouth

smaller
small intestine
saliva
digestion

- The changing of food to a form the body can use is called _____.
- Digestion _____ food. Digestion also makes food molecules _____.
- Digestion takes place in a body tube called the _____.
- The parts of the digestive tract (in order) through which food passes are the _____, the _____, the _____, the _____, and the _____.
- In the mouth, food is broken into smaller pieces by the _____. Food in the mouth is moistened by _____.
- Starch digestion starts in the _____.
- Protein digestion starts in the _____.
- Most digestion takes place in the _____. This is also where all digestion is _____.

HOW FOOD MOVES ALONG THE DIGESTIVE TRACT

Food in the digestive tract does not move by itself. It does not just "drop" through the body. Food is squeezed along the digestive tract by *muscles*.

These muscles work by themselves. We don't have to think about it. It is an involuntary action. It even happens when we are asleep! This involuntary action is called *peristalsis* [per ih STALL sis].

Peristalsis starts in the esophagus right after you swallow. It continues along the entire digestive tract.

Peristalsis works in only one direction—except when we are ill. For example, reverse peristalsis in the stomach or esophagus causes us to "throw up."

Throwing up, or vomiting, is one way the body gets rid of things that can harm us.

TRY THIS!

Get a rubber tube. Wet the inside.

Put in a marble.

Pinch it forward.

This will give you an idea of how peristalsis moves food through the digestive tract.

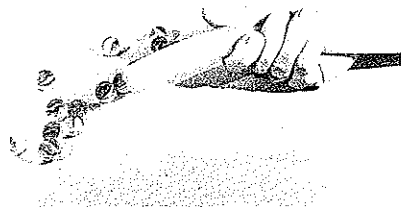


Figure B

ABOUT PERISTALSIS

Look at Figure C.

Write the correct term in each blank to answer the question.

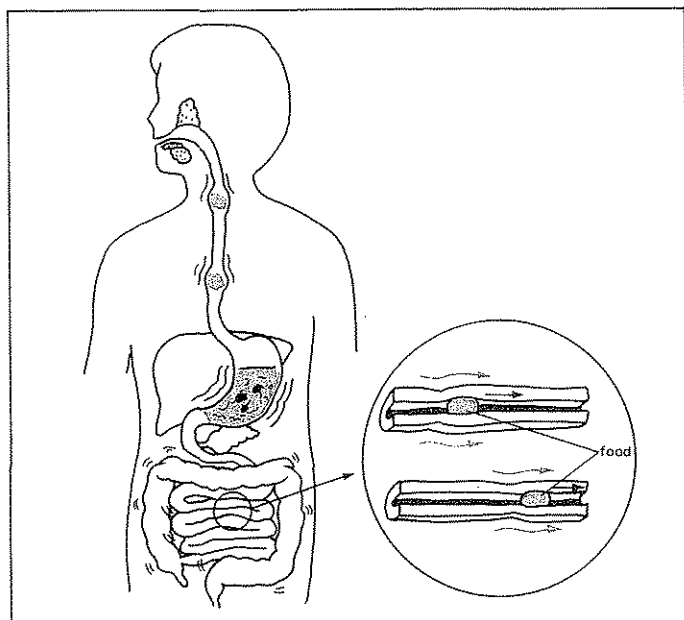


Figure C

Peristalsis moves food along the whole digestive tract.

1. Where does peristalsis start? _____
2. Where does peristalsis end? _____
3. Voluntary means "acting by choice." Is peristalsis voluntary? _____
4. What word means not acting by choice? _____

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--------------------------|--|
| 1. _____ appendix | a) where food is digested |
| 2. _____ digestion | b) openings of the digestive tract |
| 3. _____ digestive tract | c) moves food through the digestive tract |
| 4. _____ peristalsis | d) the changing of food by the body |
| 5. _____ mouth and anus | e) found at the beginning of the large intestine |

IDENTIFY Identify the parts of the digestive tract by writing the letter from **THE PARTS** Figure D next to the name of the part.

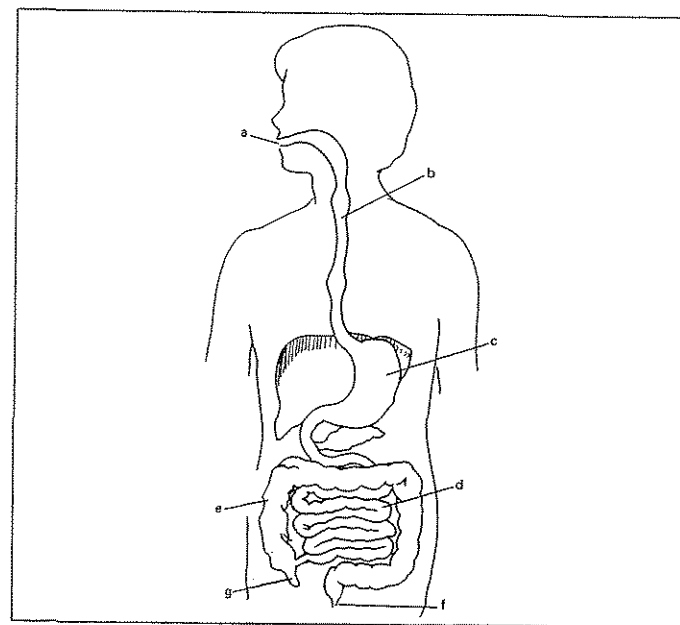


Figure D

- | | |
|--------------------------|--------------------|
| 1. small intestine _____ | 5. anus _____ |
| 2. stomach _____ | 6. esophagus _____ |
| 3. mouth _____ | 7. appendix _____ |
| 4. large intestine _____ | |

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

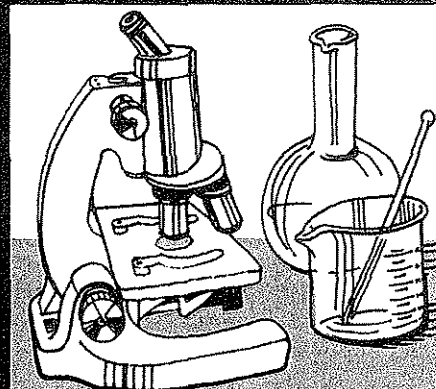
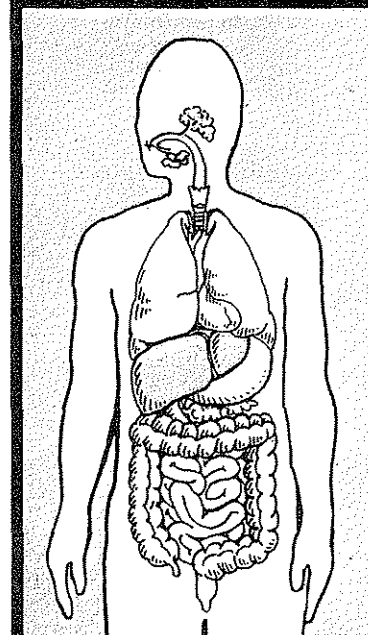
1. TENISODIG _____
2. SENITNITES _____
3. HOTCAMS _____
4. SUNA _____
5. HOTUM _____

REACHING OUT Why are the intestines coiled?

RESEARCH Look up "appendix" in an encyclopedia. What is the job of the appendix?

HOW DO GLANDS HELP DIGESTION?

5



enzyme: a kind of chemical made by the body

digestive system: all the parts of the body that have to do with digestion

gland: special group of cells that make enzymes

AIM | How do glands help 5 | digestion?

Your body is like a chemical factory. It makes many kinds of chemicals.

Some of the chemicals your body makes are called enzymes [EN zimes]. Enzymes are useful to your body in many ways. You cannot live without them.

Some enzymes help digest food. They are called *digestive* enzymes. Digestive enzymes are made by special groups of cells called *glands*.

Many tiny digestive glands are found *inside* the digestive tract. They are within the walls of the *stomach* and *small intestine*. These glands empty right into the stomach and small intestine.

Three kinds of digestive glands are found *outside* the digestive tract. They are the *salivary* [SAL i ver ee] glands, the *liver*, and the *pancreas* [PANG kree us]. The liver and pancreas are found near the stomach. The three pair of salivary glands are near the mouth.

Enzymes from these glands enter the digestive tract through small tubes. These glands help in digestion although no food passes through them.

The digestive tract along with its helping glands make up the digestive system.

HOW GLANDS HELP DIGEST FOOD

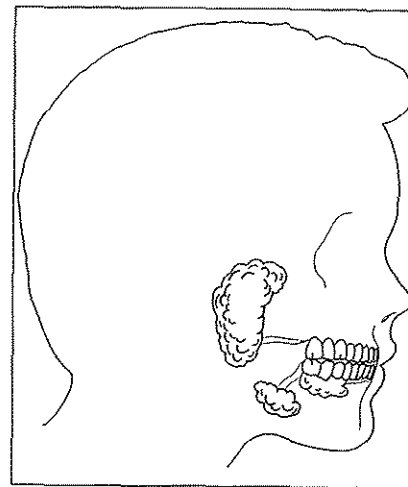


Figure A The salivary glands.

THE SALIVARY GLANDS

The salivary glands produce *saliva* [suh LY vuh]. Saliva is *mostly water*. It also contains an enzyme called *ptyalin* [TY uh lin].

Water in saliva moistens food. This makes the food easier to swallow.

Ptyalin starts changing starch to simple sugar.

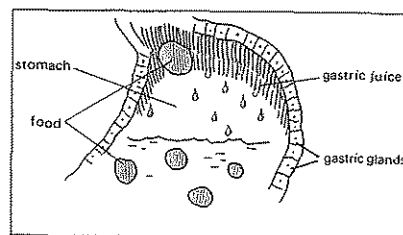


Figure B The gastric glands are located in the walls of the stomach.

THE STOMACH

The digestive glands of the stomach are called *gastric glands*. These glands secrete (give off) a liquid called *gastric juice*.

Gastric juice contains the enzymes *pepsin* and *rennin*. It also contains *hydrochloric acid*.

- Pepsin starts protein digestion.
- Rennin "curdles" milk. It changes liquid milk protein to a "cheeselike" substance. This keeps the protein from passing through the digestive tract too quickly. It gives protein-digesting enzymes time to digest the protein.
- Hydrochloric acid. Pepsin can only digest protein properly in an *acid* environment. Hydrochloric acid, in the stomach, provides this environment.

THE LIVER

The liver is the largest gland in the human body. It produces a liquid called bile. Bile is not an enzyme. But it is very important in fat digestion.

Bile is stored in the *gall bladder*. When you eat fat or oil, the gall bladder squeezes. Some bile is forced out of the gall bladder. It goes into the small intestine. Bile mixes with the food in the small intestine.

Bile breaks fat into tiny pieces. It "prepares" the fat for fat-digesting enzymes.

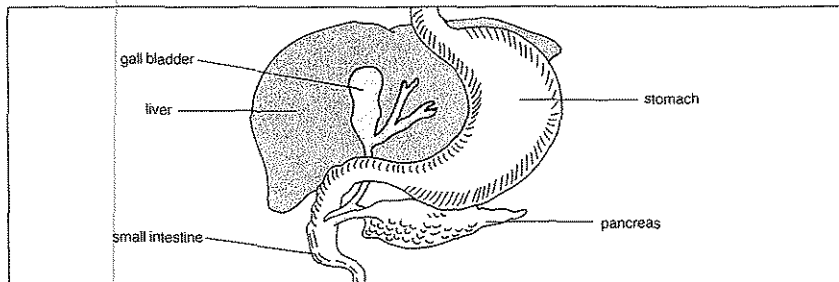


Figure C

THE PANCREAS AND THE SMALL INTESTINE

The pancreas and the small intestine produce enzymes. These enzymes complete the digestion of all nutrients.

Look at Figure C carefully. Then answer the questions.

- Enzymes from the pancreas empty into the _____.
- Which other digestive liquid mixes with the enzymes from the pancreas?

The chart below tells the story of how digestion in the small intestine changes the chemicals of food:

STARTING PRODUCT		END PRODUCT
starches and double sugars	change to	simple sugar
proteins	change to	amino acids
fats and oils	change to	simpler fatty substances

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---------------------------|--------------------------------|
| 1. _____ liver | a) chemicals made by the body |
| 2. _____ enzymes | b) starting point of digestion |
| 3. _____ glands | c) make body chemicals |
| 4. _____ digestive system | d) largest gland |
| 5. _____ mouth | e) digestive tract and glands |

LABEL THE DIAGRAM Find each part of the digestive system and write its letter in the blank.

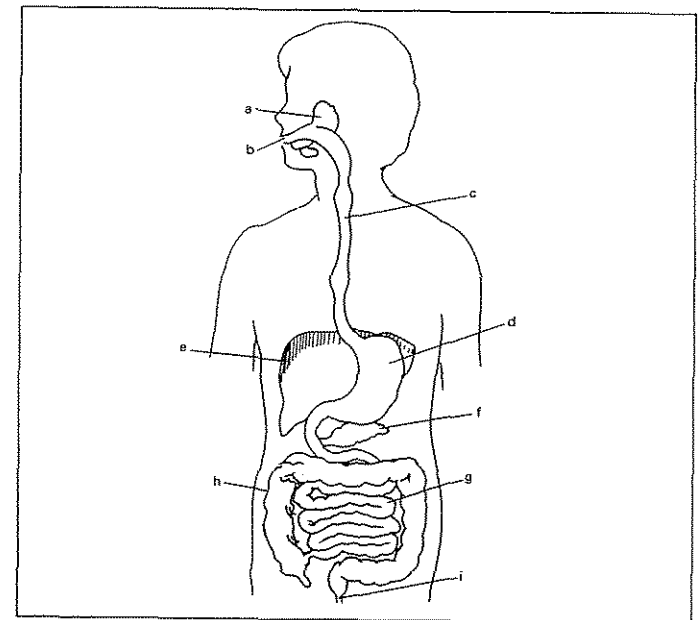


Figure D

- | | |
|--------------------------|--------------------------|
| 1. stomach _____ | 6. small intestine _____ |
| 2. liver _____ | 7. anus _____ |
| 3. large intestine _____ | 8. salivary glands _____ |
| 4. mouth _____ | 9. esophagus _____ |
| 5. pancreas _____ | |

COMPLETING SENTENCES

Complete the sentences with the words below. One word is used twice.

simple sugar
small intestine
outside
salivary glands
digestive enzymes

ptyalin
fats and oils
smaller molecules
glands
pancreas

liver
gall bladder
large molecules
starch
stomach

- Digestion changes _____ to _____.
- Enzymes are produced by groups of cells and tissues called _____.
- Chemicals that help digest food are called _____.
- Digestive glands are found within and _____ the digestive tract.
- Digestive glands *within* the digestive tract are found in the walls of the _____ and the _____.
- The digestive glands that are found outside the digestive tract are the _____, the _____, and the _____.
- The enzyme found in saliva is _____.
- Ptyalin starts to change _____ to _____.
- Bile is produced by the _____. It is stored in the _____.
- Bile breaks up _____.

END Fill in the correct answers.

PRODUCTS,
PLEASE

- The end product of fat digestion is _____.
- The end product of starch digestion is _____.
- The end product of double sugar digestion is _____.
- The end product of protein digestion is _____.

TRY THIS EXPERIMENT

Purpose: To show that pepsin needs hydrochloric acid to work.

What you need

three small pieces of lean meat
pepsin liquid
2% hydrochloric acid
water
three test tubes and rack



What to do

- Place one piece of meat in each test tube. Label the test tubes A, B, and C.
- To test tube A, add the pepsin liquid until it is one-quarter full. Then add water until it is half full.
- To test tube B, add the same amount of pepsin. Then carefully add hydrochloric acid until the test tube is half full.
- To test tube C, add water until it is half full. This test tube is our *control*. The control allows us to compare what happens to the meat with and without the enzymes.

Put the test tubes in the rack. Let them stand overnight. See Figure H.

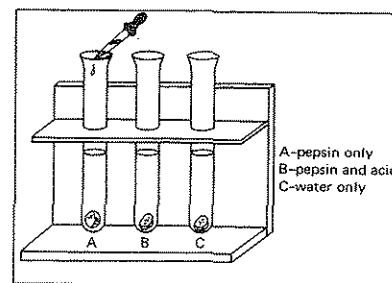


Figure G

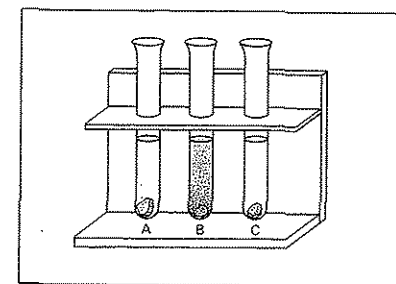


Figure H 24 hours later

What you saw

- The meat in test tube C _____ change.
did, did not
- The meat in test tube B has changed _____.
only slightly, a great deal
- The meat in test tube A has changed _____.
only slightly, a great deal

4. a) The meat has almost completely dissolved in test tube _____
A, B, C
- b) Most of the meat in this test tube has changed to a _____
solid, liquid
5. In which test tube has no digestion taken place? _____
A, B, C
6. In which test tube has only slight digestion taken place? _____
A, B, C
7. In which test tube has the most digestion taken place? _____
A, B, C

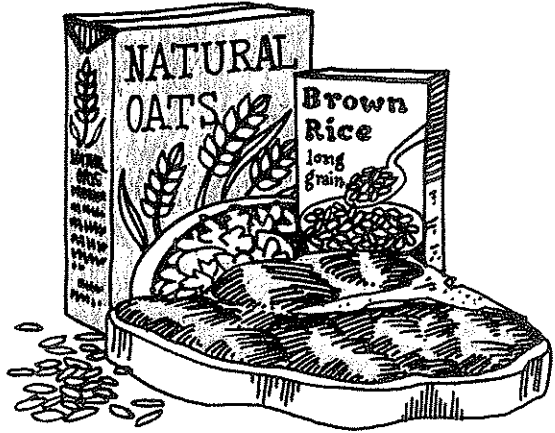
What you learned

1. Water _____ digest protein.
does, does not
2. Pepsin alone _____ digest protein, but very _____.
does, does not slowly, fast
3. a) Pepsin digests protein quickly when it is mixed with an _____.
(one word)
- b) Name the acid in gastric juice. _____
4. Digestion changes _____ molecules into _____ molecules.
large, small large, small

REACHING OUT

Sometimes a gall bladder becomes diseased. It has to be taken out. People can live without their gall bladders. How would they have to change their diets?

WHAT USEFUL THINGS DO WE GET FROM FOOD?

	6
	
	nutrients: useful chemicals that we get from food

AIM | What useful things do we get 6 | from food?

You must eat to stay alive. But eating alone is not enough. To stay healthy, you must eat the right kinds of food. The right kinds of food supply certain important chemicals called nutrients [NEW tree ents].

There are six groups of nutrients. Most foods supply several nutrients. But many foods are very rich in one or two nutrients.

All the nutrients work together to keep you in good health. Life cannot go on without these nutrients.

CARBOHYDRATES

Carbohydrates [kar bo HY drates] supply energy. There are two kinds of carbohydrates: sugars and starches.

FATS AND OILS

Fats and oils also supply energy. In addition, they help keep the body warm. Fats and oils also lubricate parts of the body.

PROTEINS

Proteins [PRO teenz] are needed to build and heal tissue. Protein is an important part of protoplasm, the living material of cells.

VITAMINS

Vitamins [VY tuh minz] help control chemical reactions in the body. For example vitamins control the amount of energy that cells give off. Vitamins also prevent certain diseases.

MINERALS

Minerals are important for healthy tissue. For example, minerals build strong bones and teeth. Muscles, nerves, and blood also need minerals.

WATER

Cells are mostly water. The life functions cannot take place without it. Blood, too, is mostly water. And, you know how important blood is. It carries oxygen, digested food, and nutrients to all the cells of the body. It also carries away wastes.

WHERE DOES OUR FOOD COME FROM?

- Some animals eat only plants. They are called herbivores.
- Some animals eat only meat (other animals). They are called carnivores.
- Some animals eat plants and meat. An animal that eats plants and meat (other animals) is called an omnivore. Bears, mice, and birds are examples of omnivores. So are humans.

Think of all the things you eat. Do you eat only plants? Do you eat only meat? Probably not. You obtain your nutrients from both plants and other animals.

Ten common foods are listed in the chart. Some of these foods come only from plants. Some come only from animals. Others are mixtures of plant and animal products. You decide where each food comes from.

I. Mark a P next to the foods that come only from plants. Mark an A next to the foods that come only from animals. Mark a P/A next to foods that are mixtures of both plants and animals. Then, answer the question next to each food.

	FOOD	P, A, or P/A	Do you eat this food?
1.	bread		
2.	corn		
3.	lamb chops		
4.	clam chowder		
5.	steak		
6.	pancakes		
7.	beef stew		
8.	milk		
9.	eggs		
10.	tuna salad		

II. Answer these questions.

1. Do people eat only plants? _____
2. Do people eat only animals? _____

3. a) What kind of foods do most people eat? _____
 b) What do we call any animal that eats both plants and animals?

4. What do we call the useful chemicals we get from food? _____

WATER AS A NUTRIENT

It is hard to think of water as a nutrient. But it is. In fact, water is one of the most important nutrients. Why is water so important?

- Our cells are mostly water.
 - The life functions take place in an environment that is mostly water.
- We can live for quite a while without food. But we can live for only a few days without water.

All foods contain water. Some foods have a great amount of water. Others, have only a little water. We can find out if a food contains water by performing a simple test.

TESTING FOR WATER



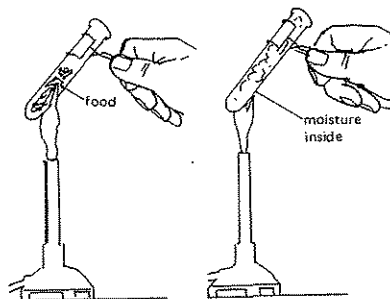
What You Need

test tube and holder
 food to be tested (pieces of fruit or vegetables or any other food)
 Bunsen burner

How To Do The Test

- 1) Place the food into the test tube.
- 2) Heat gently over Bunsen burner. Be sure to tilt the tube away from you.

Moisture on the inside of the test tube near the top means that the food has water.



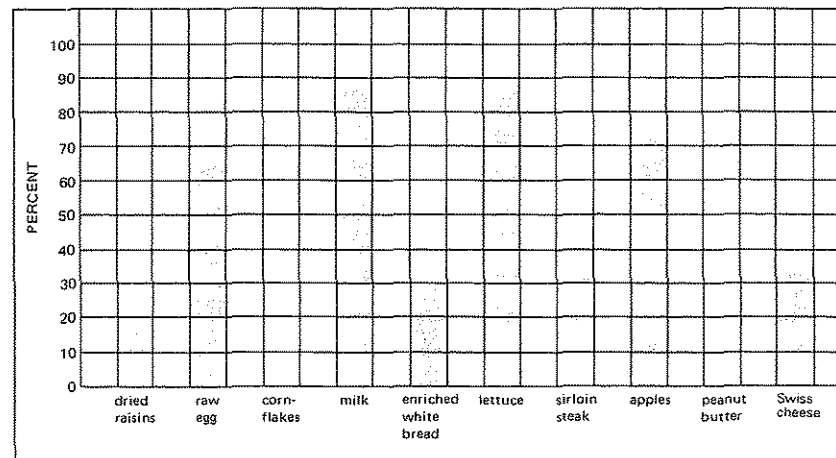
What You Learned

Answer these questions about the test for water.

1. Did moisture form on the inside of the tube? _____
2. Do you think the moisture came from the food or the air? _____
3. Does the food that you tested have water? _____

WORKING WITH GRAPHS

This graph shows, in percent, how much water there is in some foods. Study the graph for a few minutes. Then answer the questions below.



1. What percent water does each of these foods have?

- | | |
|-------------------------------|------------------------|
| a) dried raisins _____ | f) lettuce _____ |
| b) raw egg _____ | g) sirloin steak _____ |
| c) cornflakes _____ | h) apples _____ |
| d) milk _____ | i) peanut butter _____ |
| e) enriched white bread _____ | j) Swiss cheese _____ |

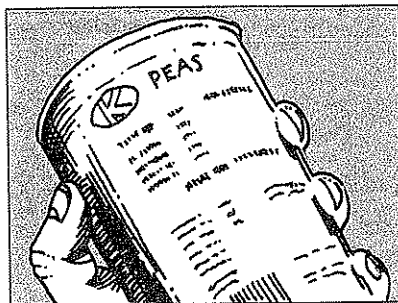
2. Which of these foods has the most water? _____

3. Which of these foods has the least water? _____

MATCHING Match the two lists. Write the letter of the correct answer on the line next to the number.

- | | |
|------------------------------|--|
| 1. _____ proteins | a) carbohydrates |
| 2. _____ starches and sugars | b) mostly water |
| 3. _____ vitamins | c) build and repair tissue |
| 4. _____ cells | d) build strong bones |
| 5. _____ minerals | e) help control chemical reactions in the body |

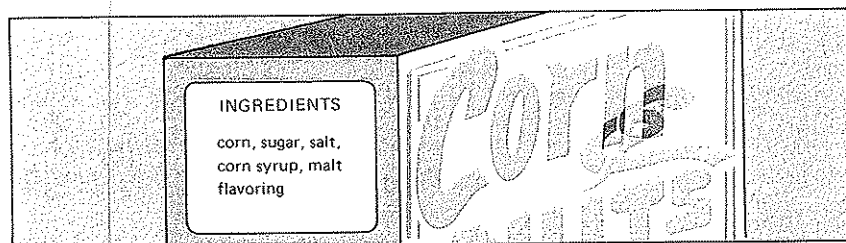
READING LABELS



Every packaged (canned, boxed, or frozen) food has a label. That's the law! The label lists the ingredients found in the food. The ingredients are listed in order of quantity (amounts).

The ingredient found in the greatest amount is listed first. The ingredient with the smallest amount is listed last.

The main contents of a popular cereal are listed below. Study the label. Then answer the questions.

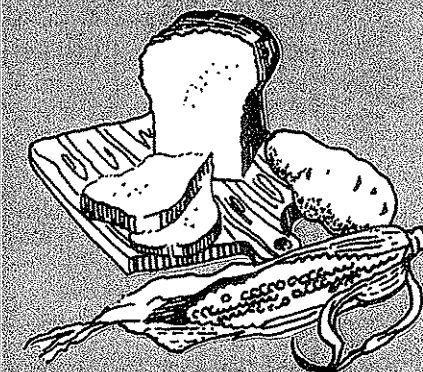


1. The ingredient with the greatest amount is _____
2. The ingredient with the least amount is _____
3. This cereal tastes good to many people.
 - a) Why do you think many people like the taste? _____
 - b) What is your opinion? Is this a healthy cereal? yes. no

Why? _____
4. The label tells us the percent rank of each ingredient.
 - a) Does it give the actual percent? _____
 - b) Is this good or bad for the consumer (the person who buys the product)? _____

WHAT ARE CARBOHYDRATES, FATS, AND OILS?

7



carbohydrates: sugars and starches
fat: a lipid that is a solid at room temperature
oil: a lipid that is a liquid at room temperature

AIM | What are carbohydrates, fats, and oils?

7

CARBOHYDRATES

Make a list of the foods you eat in one day. Chances are that about half your diet is made up of *carbohydrates*. That's about normal for most Americans.

What are carbohydrates? Carbohydrates are chemical compounds. They are made up of only *carbon*, *hydrogen*, and *oxygen*—in certain proportions (balanced amounts).

There are two groups of carbohydrates—*starches* and *sugars*. Starches and sugars are “energy” foods.

During digestion, starches and double sugars are changed to *glucose*. Glucose is the simple sugar our bodies “burn” during respiration. This supplies the energy we need to carry out the life functions.

FATS AND OILS

Fats are solid at room temperature. Oils are liquid.

Fats and oils are also called *lipids*. In some ways, lipids are like carbohydrates. They, too, contain only *carbon*, *hydrogen*, and *oxygen*. But the proportions of these elements are different in lipids. That is why lipids are not grouped with the carbohydrates.

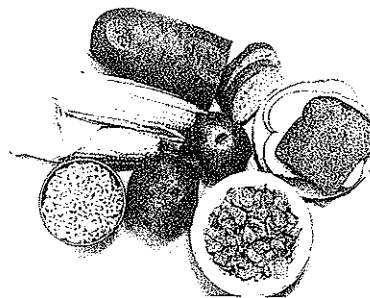
Lipids, like carbohydrates, are “energy” nutrients. In fact, lipids provide more than twice the energy of an equal weight of carbohydrates.

Fats and oils are very important. They cushion the body and give it shape. Every cell membrane contains fat.

Our bodies contain fat tissue. Important nutrients are stored in this tissue. Fat also helps to insulate the body against the cold.

Fats, oil, and carbohydrates are very important nutrients. We can say they are necessary for life itself.

SOURCES OF STARCH



Many of the foods we eat contain a great deal of starch. For example, foods like pasta, corn, potatoes, bread, rice, and cereals are mostly starch.

1. What part of a spaghetti dinner is mostly starch? _____

SOURCES OF SUGAR



Many foods like fruits, beets, and honey are rich in *natural* sugar.



Other foods, like cereals, soft drinks, and desserts, have *added* sugar. This is *processed* sugar—like table sugar.

Processed sugar is found in most canned, packaged, and frozen foods we buy—and recipe foods we make at home. Even some baby foods have added sugar. It seems that we like the taste because of its sweetness. And we start training children early to develop a “sweet tooth”.

2. You know from experience that processed sugar is not good for you. Why? Describe at least two reasons. _____
3. Name three foods that contain processed sugar. _____, _____, and _____
4. Name three foods that contain natural sugar. _____, _____, and _____

TESTING FOR SIMPLE SUGAR

What You Need

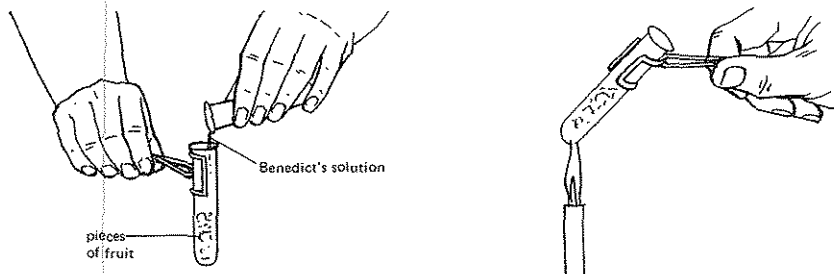
small pieces of apple (or any other fruit)
Benedict's solution
test tube and holder
Bunsen burner



How To Do The Test

- 1) Place a few small pieces of the apple in the test tube.
- 2) Add Benedict's solution (make the test tube about one-third full).
- 3) Place the test tube over a flame so that the bottom of the tube just touches the flame. Tilt the test tube so that it is pointed away from you.
- 4) Boil the mixture for about one minute. **BE CAREFUL!**

If the Benedict's solution turns orange or brick red, then simple sugar is present. If it turns a darker orange, then a lot of simple sugar is present. A light greenish color means very little sugar is present.



What You Learned

Answer the following questions about the test for sugar.

1. Did the mixture change color? _____
2. What color did the mixture become? _____
3. Does the fruit tested have simple sugar in it? _____
4. What is the name of the special chemical that we used to test for simple sugar?

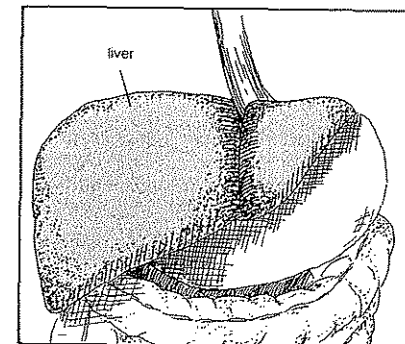
HOW THE BODY STORES SUGAR

Extra glucose is stored in the liver in the form of glycogen. Glycogen is a starch.

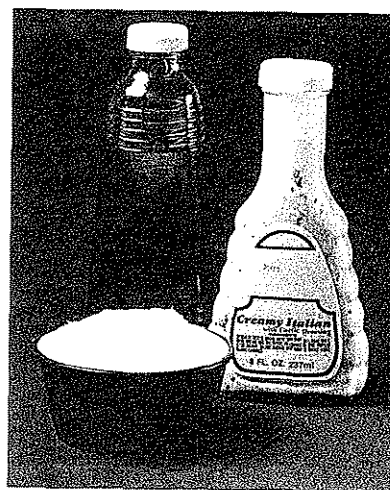
When the body needs extra energy, some of the glycogen changes back to glucose. The glucose then goes to the cells.

The glucose is burned by the cells to produce energy.

1. What carries the glucose from the liver to the cells? _____



SOURCES OF FATS AND OILS



Cooking oils, lard, butter, and salad dressings are rich in fats and oils. Fats and oils are very important nutrients; however too much of these nutrients is unhealthy.

Certain fats and oils can clog blood vessels. This can lead to a heart attack or a stroke.

Fat build-up in the blood vessels starts early in life It cannot be stopped. But, it can be slowed. How? By reducing your intake of fats and oils.

Why not speak to your doctor about this. Your doctor can give you good advice about the amounts of fats and oils you should include in your diet.

HOW THE BODY STORES FAT

Fat is found all over the body. It is found under the skin, and among muscles and other organs.

If you eat too much, the liver becomes "filled up" with glycogen. There is no more room. Any additional glucose that enters the liver is changed to **fat** instead of glycogen.

This fat is added to other fat tissue all over the body. The fat becomes thicker and thicker. That is why people "become fat" when they overeat.

TESTING FOR STARCH

What You Need

Slice of bread or potato
iodine or Lugol's solution
dropper



How To Do The Test

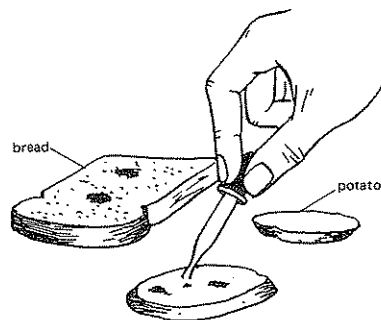
Place a drop of iodine or Lugol's solution on the food.

The food will turn blue-black if it has starch.

What You Learned

Answer the following questions about the test for starch.

1. Did the bread or potato turn blue-black? _____
2. Does the bread or potato have starch? _____
3. What liquid did you use to test for starch? _____



TESTING FOR OIL OR FAT

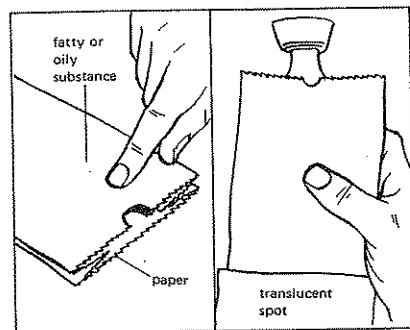
What You Need

butter (or margarine)
piece of brown wrapping paper

How To Do The Test

Rub a small amount of the butter on the paper.

Fat or oil makes a spot on the paper. Light can pass through the paper at that spot. The oil makes the paper translucent [trans LOO sent].



What You Learned

Answer these questions about the test for oil.

1. Did the butter (or margarine) make a spot on the paper? _____
2. Did the oil make the paper translucent? _____
3. Does the material you tested contain oil? _____

COMPLETING SENTENCES

Complete the sentences with the words below.

digestion
hydrogen
existing fat
fats
liquid
twice

oxygen
solid
sugars
glucose
respiration

oils
starches
glycogen
carbon
liver

1. Carbohydrates are compounds made up of only _____, _____, and _____.
2. The two kinds of carbohydrates are _____ and _____.
3. The "burning" of a "fuel" by a cell to obtain energy is called _____.
4. The "fuel" of respiration is _____.
5. The body changes starches and sugars to glucose during _____.
6. Two groups of lipids are _____ and _____.
7. Lipids supply more than _____ the amount of energy of carbohydrates.
8. Fats are _____ at room temperature; oils are _____.
9. The body stores reserve glucose in the _____. This reserve glucose is stored in the form of _____.
10. Extra lipids are stored along with _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---|-------------------------|
| 1. _____ glucose | a) glucose in "storage" |
| 2. _____ every cell membrane | b) fats and oils |
| 3. _____ glycogen | c) cell fuel |
| 4. _____ lipids | d) some jobs of fat |
| 5. _____ cushions, insulates, and gives shape | e) contains fat |

REACHING OUT

Glycogen can change back to glucose.

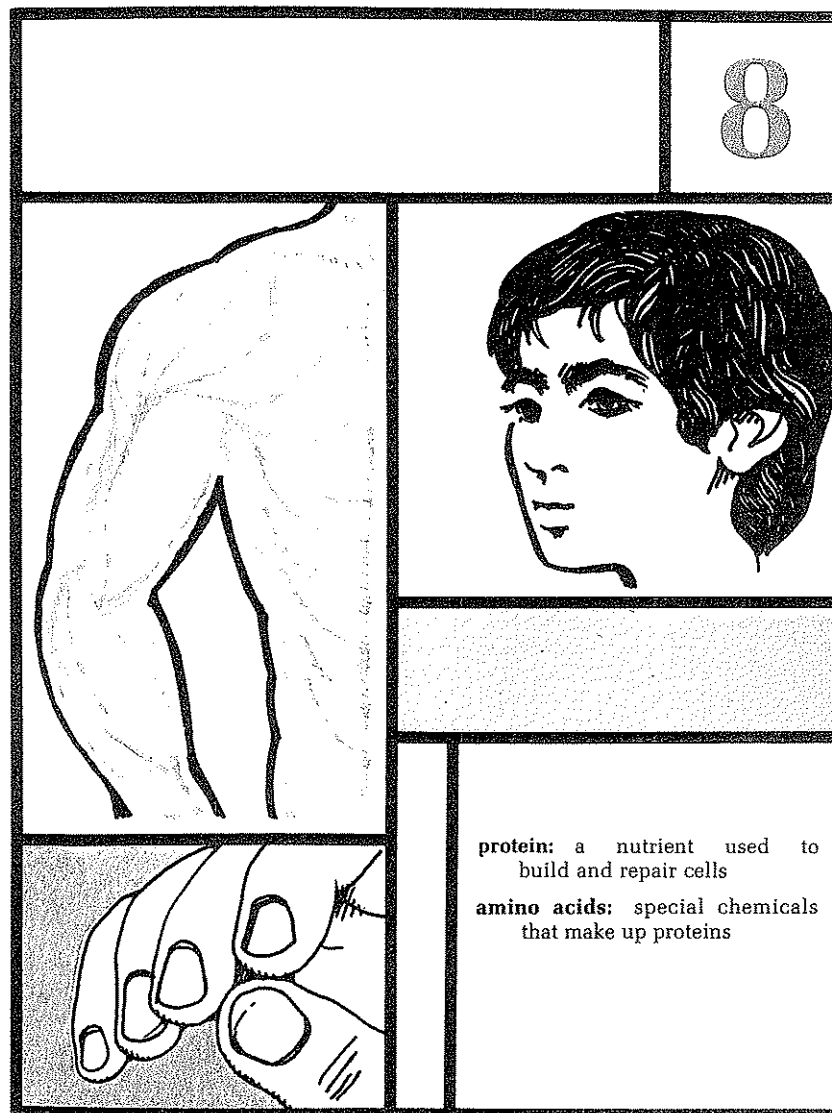
Fats can also change back to glucose.

When you diet, the body uses its own "reserve fuels" of glycogen and fat.

Which changes back to glucose first, the glycogen or the fat? Explain your answer.

WHY DOES THE BODY NEED PROTEIN?

8

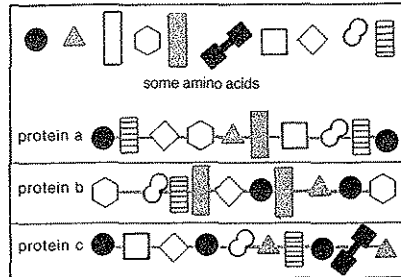


HOW THE BODY MAKES PROTEINS

Look at each of the pictures below and read about them. Then answer questions 1-7 on the next page.

Each one of these shapes stands for an amino acid. There are twenty-two kinds of amino acids.

Amino acids link up to make proteins. Different kinds of link-ups make different kinds of protein.

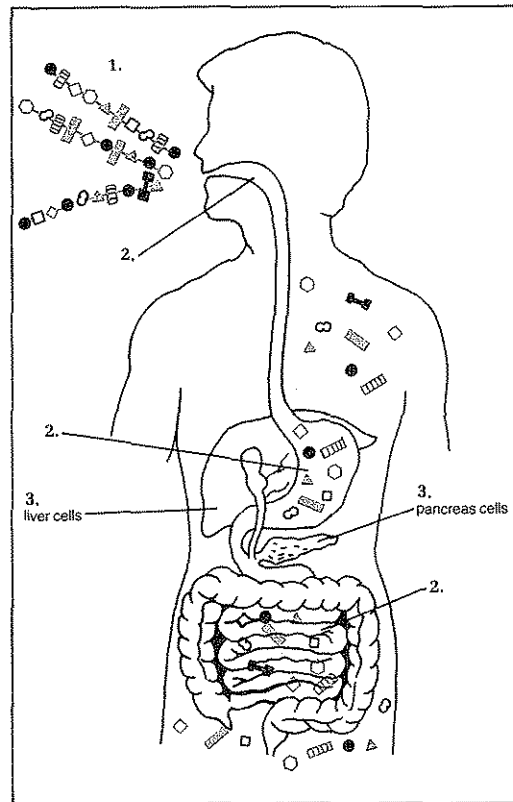


1. Food contains proteins. We eat food.

2. Digestion separates the amino acids in the food protein. Blood sends the amino acids to every cell in the body.

3. The cells put these amino acids together again. They become proteins. The cells also put together the amino acids made by the body.

The body needs thousands of different kinds of proteins. Each cell makes the kinds that it needs.



ANSWER THESE QUESTIONS

1. How many kinds of amino acids are there? _____
2. What is built when amino acids link up? _____
3. How many kinds of proteins are there? _____
4. Where do we get proteins? _____
5. What does digestion do to the protein we eat? _____
6. How do amino acids get to cells in every part of the body? _____
7. What do the cells do with the amino acids? _____

COMPLETING SENTENCES

Complete the sentences with the words below.

twenty-two
cell repair
cells
hair

digestion
protoplasm
amino acids
eight

proteins
fourteen
cell building
nails

1. The two most important jobs of proteins are _____ and _____.
2. Living cell material is called _____.
3. Protoplasm is made mostly of _____.
4. Proteins are built from linked-up chemicals called _____.
5. The number of known amino acids is _____.
6. The number of amino acids a person's body can make is _____.
7. The number of amino acids that we must get from food is _____.
8. _____ separates proteins into its amino acids.
9. The _____ put the amino acids together again as protein.
10. Two parts of your body that are mostly protein are your _____ and _____.

PROTEIN IN THE BODY



Muscle cells have a large amount of protein. Healthy muscles have good "muscle tone". They help hold the body straight.

Hair and nails are made mostly of protein. A doctor often studies a person's nails. They can give clues to possible health problems.

TESTING FOR PROTEIN

What You Need

raw egg white in water
Biuret solution
test tube

How To Do The Test

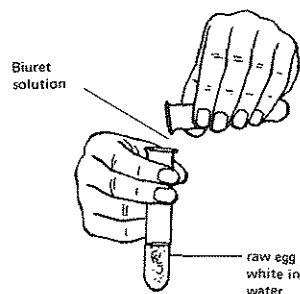
- 1) Pour the mixture of egg white and water into the test tube (make about one-third full).
- 2) Add an equal amount of Biuret solution.

Protein turns Biuret solution violet or pink.

What You Learned

Answer these questions about the test for protein.

1. Did the solution turn color? _____
2. What color did the solution become? _____
3. Does egg white have protein? _____



TRUE OR FALSE

Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Proteins are nutrients.
2. _____ We can live without proteins.
3. _____ Proteins are made from amino acids.
4. _____ The body makes amino acids.
5. _____ The body makes all the amino acids it needs.
6. _____ We get some amino acids from food protein.
7. _____ Digestion links up amino acids.
8. _____ There are thousands of kinds of proteins.
9. _____ All cells need the same kinds of proteins.
10. _____ Cells make the kinds of proteins they need.

MATCHING

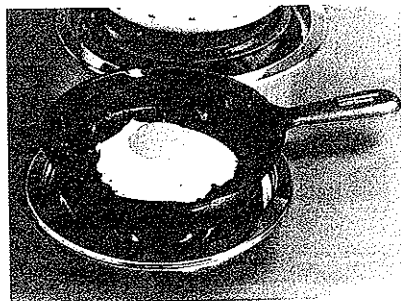
Match the two lists. Choose the best answer. Then write the correct letter on the line next to each number.

- | | |
|---|-------------------------------|
| 1. _____ protoplasm | a) main jobs of proteins |
| 2. _____ twenty two amino acids | b) cannot be made by the body |
| 3. _____ eight amino acids | c) can be made by the body |
| 4. _____ fourteen amino acids | d) built from proteins |
| 5. _____ cell repair and building new cells | e) link up to build protein |

REACHING OUT

Some things can change and then change back again. Other things can change, but cannot change back again.

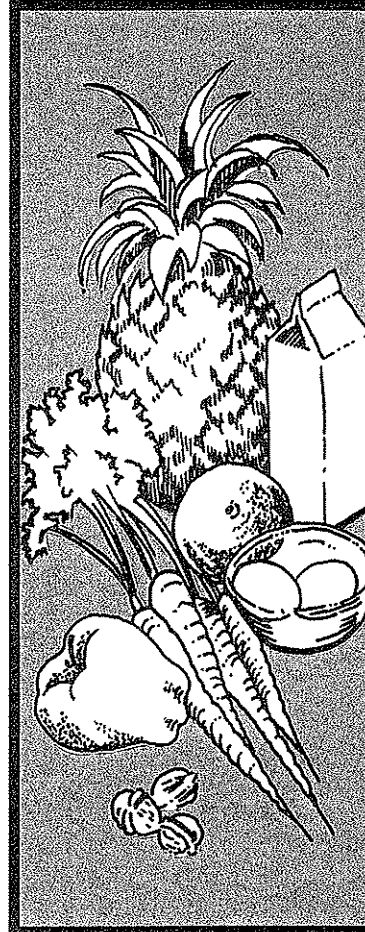
Eggs contain a protein called *albumen*.



1. What can you do to albumen to change it so that it cannot be changed back into albumen? _____
2. Describe how albumen changes. _____

WHAT ARE VITAMINS AND MINERALS?

9



organic compound: a compound that contains the element carbon

AIM | What are vitamins and minerals?

9

Did your parents ever call out this reminder? "Don't forget to take your vitamins."

Vitamins go hand-in-hand with minerals. They are vital nutrients. We get vitamins and minerals from food. But, do we obtain enough? We can't always be sure. For this reason, doctors sometimes advise us to take a vitamin and mineral supplement [SUP luh munt] each day. Do you take one?

VITAMINS

Vitamins help our cells work properly. For example, vitamins help our cells release energy. Vitamins are also needed for normal growth, reproduction, and making enzymes. Vitamins do not build or repair cells like proteins do.

Vitamins are organic compounds. An organic compound contains carbon and hydrogen. Most contain other elements, too.

All vitamins have scientific names. Some are also called by a letter. Have you ever heard of vitamin C? Of course you have. The scientific name for vitamin C is ascorbic [as KOR bik] acid.

Some vitamins are known by both a letter and a number. For example, thiamin is commonly called vitamin B₁. Riboflavin [RY boh FLAY vin] is called vitamin B₂.

MINERALS

Most of the minerals we need are metals. Iron, zinc, copper, and calcium are some of the important minerals our bodies need.

Minerals, like vitamins, help our cells work properly. Minerals help control growth. They also help control the energy released by cells.

Some minerals are needed for strong bones and teeth. Others, are needed to make blood. Minerals are also important parts of special body chemicals called hormones. You will learn more about hormones later.

The body needs only small amounts of most vitamins and minerals. But, these nutrients are essential for good health.

ABOUT VITAMINS

Vitamins are needed for good health. Most foods contain several vitamins. But some foods are very rich in one or more vitamins.

The pictures below show six groups of food. The foods in each group are extra rich in one particular vitamin. Name that vitamin. (Hint: Match the pictures with the food lists on the next page.)



Figure A Important sources of vitamin A.

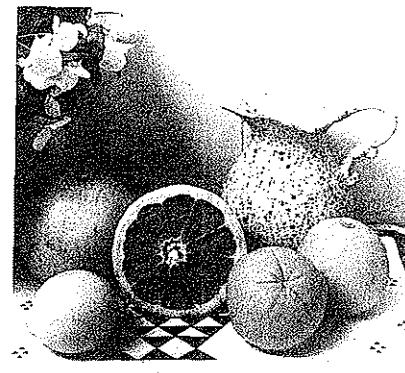


Figure B Important sources of vitamin C.

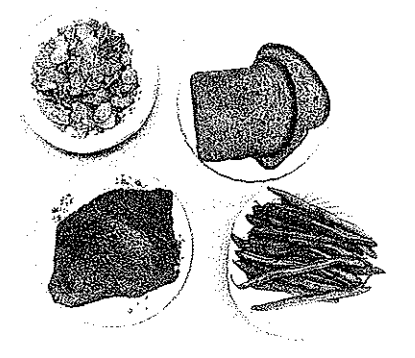


Figure C Important sources of vitamin B.

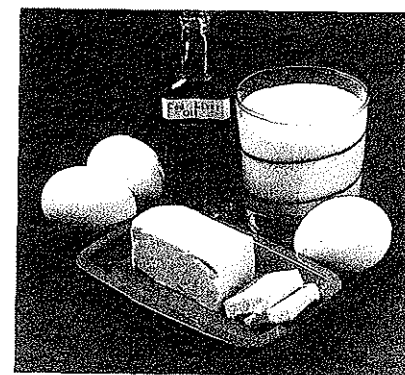


Figure D Important sources of vitamin D.

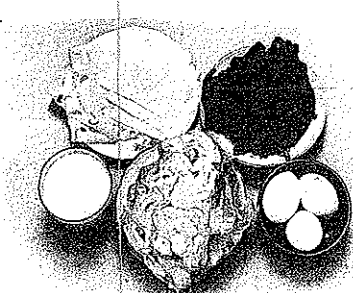


Figure E Important sources of vitamin K.



Figure F Important sources of vitamin E.

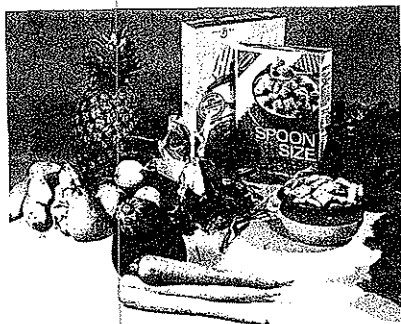
Lists of Foods

1. Citrus fruits such as oranges, grapefruits, and lemons.
2. Lettuce, milk, eggs, carrots, and cheese.
3. Milk, cheese, carrots, and liver.
4. Lean meats, whole grain bread and cereals, eggs, peas, and green vegetables.
5. Fortified milk, eggs, butter, cod liver oil.
6. Vegetables, whole grain bread and cereals, and margarine.

Rich Sources of Which Vitamin

ABOUT MINERALS

Study the chart on page 67. It lists several minerals, their importance, and what foods they are found in. Use the information in the chart to answer the questions that follow.



FOOD RICH IN POTASSIUM



FOOD RICH IN MAGNESIUM

MINERAL	IMPORTANCE	IMPORTANT FOOD SOURCES
Iron	Important in blood-building. Helps tissues and glands grow.	Liver, red meat, egg yolk, nuts, green leafy vegetables.
Calcium	Helps build strong bones and teeth. Helps blood to clot.	Milk and milk products, green leafy vegetables.
Phosphorous	Helps build strong bones and teeth. Helps muscles and nerves work properly.	Milk and milk products, liver, fish, eggs, poultry, whole grains, nuts.
Magnesium	Needed to start many enzyme actions. Helps the body use calcium and phosphorous.	Red meats, nuts, bananas, whole grains, corn, green leafy vegetables.
Iodine	Helps control the rate of respiration (the rate at which cells burn food).	Seafood, iodized salt.
Zinc	Helps wounds heal. Necessary for normal taste and smell.	Meat, liver, seafood, milk, whole grains, eggs.

Which mineral (or minerals) is especially important for each of the following activities?

1. strong bones and teeth _____
2. properly working muscles and nerves _____
3. healing of wounds _____
4. normal smell and taste _____
5. clotting blood _____
6. proper gland growth _____
7. proper energy production by the cells _____
8. rich blood _____
9. proper ptyalin action (What is ptyalin? Look back to Aim 5 if necessary.)

10. proper tissue development _____

TESTING FOR VITAMIN C

What You Need

lemon juice
indophenol (blue in color)
test tube

How To Do The Test

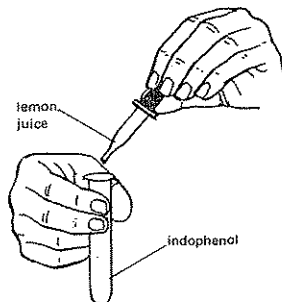
- 1) Fill about one-third of the test tube with indophenol.
- 2) Add a few drops of lemon juice. Shake the test tube. Then shake it again.

Vitamin C makes indophenol lose its color.

What You Learned

Answer these questions about the test for vitamin C.

1. Did the indophenol lose its color? _____
2. Does lemon juice have vitamin C? _____



TESTING FOR MINERALS

What You Need

food samples
crucible and stand
Bunsen burner

How To Do The Test

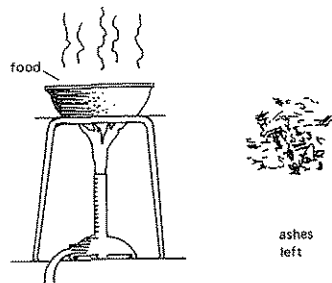
- 1) Place the food samples in the crucible.
- 2) Heat the food in the crucible.
- 3) Continue heating until a white ash remains.

When food is heated this way, minerals in the food are left behind as white ashes.

What You Learned

Answer these questions about the test for minerals.

1. Were white ashes left behind in this test? _____
2. Does this food have minerals? _____



COMPLETING SENTENCES Complete the sentences with the words below.

repair
calcium
metals
letter
vitamin B₁

regulate
hydrogen
build
iron
vitamin C

hormones
release of energy
carbon
organic compounds
zinc

1. Vitamins and minerals do not _____ and _____ cells.
2. Vitamins and minerals help the body _____ cell activity.
3. One life activity vitamins help control is the _____ by the cells.
4. Vitamins have scientific names, but many are also called by a _____.
5. Ascorbic acid is also called _____; thiamin is also called _____.
6. Vitamins are complicated _____.
7. Every organic compound contains atoms of _____ and _____.
8. Most minerals are _____.
9. Examples of minerals include _____, _____, and _____.
10. Minerals help make important body chemicals called _____.

REACHING OUT

A man visits his doctor. He has symptoms of weak bones and weak teeth.

The doctor suspects that the patient's diet does not supply enough calcium and phosphorus. However, tests show a normal level for each of these nutrients.

An undersupply of some other mineral may be causing this problem. Identify that mineral. _____

KEEPING UP WITH SCIENCE

PUTTING THE BITE ON TOOTH DECAY



Almost everyone hates to visit the dentist. But not going could be much worse—especially if you delay the visit too long. You could wind up with a mouthful of cavities—or, just a mouthful of gums. Instead of shouting, “Look ma, no cavities!” You could be moaning, “Look ma, no teeth!”

The fear of dental treatment and tooth loss, however, may become a thing of the past. Research is being done to learn more about tooth decay: how it develops, and how to stop or prevent it.

Dental problems are as old as the ages. They are mentioned in ancient records. Early Egyptians at the time of the Pharaohs even performed dental surgery.

The most common dental problem, is caries—more commonly called cavities. The main cause of caries is a bacteria named *Streptococcus mutans*, or *S. mutans* for short. About 90 to 95 percent of our cavities is caused by this microscopic “bad guy.”

S. mutans produces a substance that helps break down the sugars in our food.

The sugars become *lactic acid*. And lactic acid can wear away tooth enamel.

S. mutans also encourages the growth of other microscopic organisms. They form a sticky surface that clings to the teeth. It provides a perfect place for bacteria to live and multiply.

Bacteria, food particles, and dead tissue combine to form another sticky substance called *plaque*. It must be removed. If plaque is not removed, it changes to *tartar*, which is a very hard substance. Tartar destroys the gums and the bone that holds the teeth in place. The teeth become loose. Often they must be removed, even if they are not decayed.

Dental researchers feel that most tooth problems could be eliminated if people could resist the effects of the bacteria *S. mutans*. A vaccine that may do this job has been developed. The vaccine does not kill the bacteria. But it makes us immune to this bacteria. Then we would be able to resist its harmful effects.

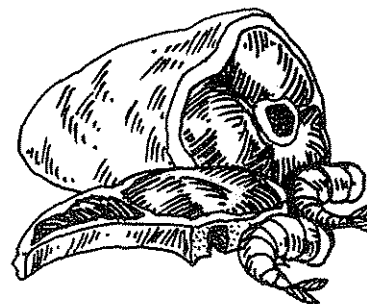
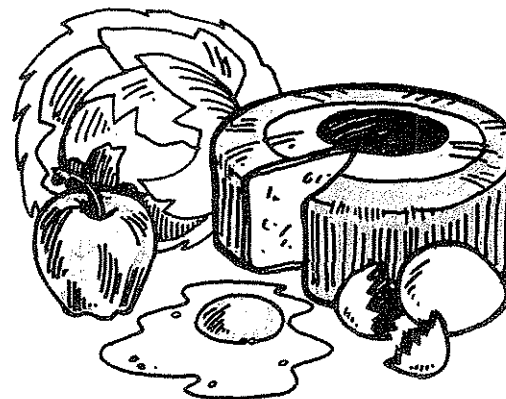
The vaccine has been tested on animals. The results are encouraging. However, we do not know if it will work on humans. And if it does work, is it safe? And if it is safe, how should the vaccine be given—by injection or by mouth? These questions must first be answered before we can look forward to “ouchless” dentistry.

In the meanwhile, continue good dental hygiene habits:

- Avoid sweets—especially the “gooey” kinds.
- Brush properly after every meal (and after snacks too.)
- Floss regularly and properly.
- Visit your dentist twice a year.

WHAT ARE DEFICIENCY DISEASES?

10



deficiency: a lack or shortage

deficiency disease: a disease caused by an undersupply of a specific nutrient

AIM | What are deficiency diseases? 10 |

Many diseases are caused by germs. Others, however, are not caused by germs. For example, diabetes develops when the pancreas stops making insulin. Insulin is a chemical that controls sugar.

Allergies are diseases, too. They are caused by damaging chemical reactions in the body.

Some diseases are caused by a lack, or undersupply, of certain nutrients. This type of disease is called a *deficiency* [dee FISH en see] disease.

These are some deficiency diseases:

RICKETS. Rickets is caused by a lack of vitamin D. This disease develops mostly in children.

Rickets prevents the proper development of bones and teeth. Bones become porous and weak. This causes bowing of the legs or knock-knees. Rickets also causes teeth to break and decay easily.

NIGHT BLINDNESS. Night blindness is caused by a deficiency of vitamin A. People with night blindness do not adjust to darkness easily. Things look dark for quite a while when they go from a brightly lit area to an area that is dimly lit.

GOITER. Goiter is caused by a lack of iodine. Iodine is a mineral. It is needed by the thyroid gland.

The thyroid gland is located in the neck. Goiter causes the neck to swell. It also causes the eyes to bulge.

Eating right can prevent deficiency diseases. And, if a deficiency disease does develop, it can be treated. How can a deficiency disease be treated? With the nutrient that was missing from the diet.

Which is better, treatment or prevention? You know the answer! Be guided by your wisdom.

In the next Aim, you will gain the knowledge to carry out your wisdom. You will learn how to choose your food wisely.

AN INTERESTING STORY ABOUT A ONCE VERY COMMON DEFICIENCY DISEASE

Why Are British Sailors Called "Limeys"?

In the early days of long sea trips, thousands of sailors died each year from a strange disease. First they would get dizzy and lose their appetite. Their mouths would get sore and their teeth would loosen. If their skin was touched even lightly, it would turn black and blue.

The name of this "sailor's disease" is scurvy [SKUR vee]. At first, no one knew what caused it. Many sailors got better after their ship reached shore. For this reason, many people said scurvy was caused by "a change in air."

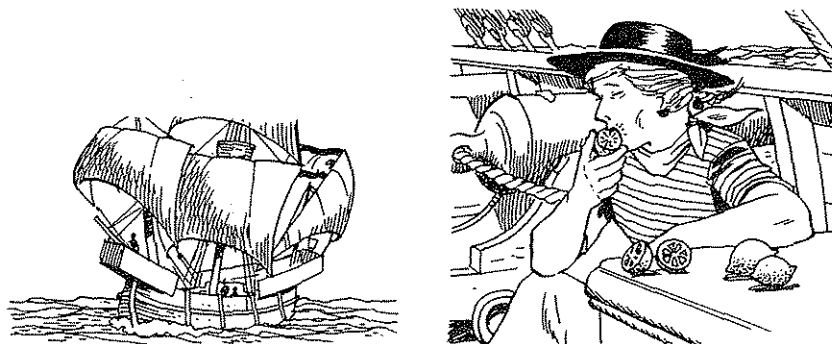
In 1535, explorer Jacques Cartier's men developed scurvy. They drank juices from a fruit tree and were cured. Other sailors were saved in the same way. No one knew why.

Two centuries passed. Sailors were still dying from scurvy. Finally, a group of British doctors studied the disease. They found that fruit juices could both cure and prevent scurvy. Still, they did not know what caused it.

After this study, English ships always carried a supply of limes. Each sailor had to eat a piece every day. Since then, British sailors have been called "limeys."

It took many years for doctors to learn the true cause of scurvy. We now know that scurvy is a deficiency disease. It is caused by an undersupply of vitamin C.

Citrus fruits are rich sources of vitamin C. Citrus fruits include oranges, grapefruits, lemons, and limes.



MULTIPLE CHOICE In the space on the right, choose the letter of the phrase that best completes each sentence.

1. The best title for this story is 1. _____
 - a) Long Sea Voyages
 - b) The History of the British Navy
 - c) The Story of Scurvy
 - d) How Vitamin C Got Its Name
2. Jacques Cartier's men were cured of scurvy because 2. _____
 - a) they drank fruit juices
 - b) the air was better
 - c) their ship reached shore
 - d) they were on a diet
3. The term "limey" started 3. _____
 - a) in 1535
 - b) before 1535
 - c) about 1735
4. British doctors discovered 4. _____
 - a) vitamin C
 - b) citrus fruits
 - c) scurvy
 - d) that citrus fruits prevent and cure scurvy
5. Oranges and limes are examples of 5. _____
 - a) vegetables
 - b) diets
 - c) citrus fruits
 - d) juices

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Only sailors can get scurvy.
2. _____ All diseases are caused by bacteria or viruses.
3. _____ Deficiency means "too much."
4. _____ Eighteenth century doctors discovered that limes have vitamin C.
5. _____ Scurvy is "catching."

SOME DEFICIENCY DISEASES AND THEIR SYMPTOMS

The chart below lists several deficiency diseases. It also lists the symptoms and causes of each disease. Study the chart carefully. Then answer the questions on pages 76 and 77.

DEFICIENCY DISEASE	SYMPTOMS	MISSING NUTRIENT	FOODS RICH IN THIS NUTRIENT
Night blindness	difficulty seeing in darkened areas; dry eyes	vitamin A	butter; cheeses; whole milk; cod liver oil; carrots and other vegetables
Beriberi	tiredness; loss of appetite; muscle cramps; paralysis	vitamin B ₁	whole grain cereals; peas; beans; yeast; many fruits and vegetables
Pellegra	rough, red skin; weight loss; intestinal problems; craziness	niacin	dairy products; fish; lean meat; and whole grain cereals
Rickets	soft bones and teeth; bowing legs or knock-knees	vitamin D	fortified milk; fish and liver oils; dairy products
Scurvy	dizziness; loss of appetite; sore gums; loose teeth, easily bruised skin	vitamin C	citrus fruits; tomatoes; fruit juices; and vegetables
Goiter	swollen thyroid gland (swelling in the neck); bulging eyes	iodine	iodized salt; fish
Anemia	tiredness; pale skin; dizziness; headache; slight fever	iron	red meats (especially liver); raisins; prunes; whole wheat breads

YOU BE THE DOCTOR!

Answer each of the questions. Look back at the chart for the answers. Search carefully and be patient and you will get them all correct.

But remember, this is make believe. In real life, never diagnose or treat your own health problems. SEE YOUR DOCTOR!

1. James is always tired. He lacks energy and looks pale.

a) Which mineral deficiency disease might James have?

b) Which mineral might James be lacking? _____

c) What food or foods might help this problem? _____



2. Ann, too, is sluggish and tired. She also has a poor appetite. Sometimes Ann's muscles cramp.

a) What vitamin deficiency disease might Ann have?

b) Which missing vitamin might be the cause? _____

c) What food or foods might help Ann's problem? _____



3. It is a sunny day. Tom goes into a movie house. He stumbles around looking for a seat. Things look very dark to him for several minutes.

a) Which deficiency disease might Tom have? _____

b) Which nutrient might be missing from his diet? _____

c) What foods should Tom eat to solve this problem? _____



4. Mrs. Jones lives in an inland city. Her neck has begun to swell and her eyes to bulge.

a) Which deficiency disease might Mrs. Jones have? _____

b) Which missing nutrient causes this disease? _____

c) Which foods should Mrs. Jones eat? _____

COMPLETING SENTENCES Complete the sentences with the words below.

nutrients
phosphorus
treated
vitamin C
germs

eat properly
false
calcium
whole grains
prevented

not enough
milk
deficiency
prevention

- Many people believe that all diseases are caused by _____. This is _____.
- Some diseases are caused by an undersupply of certain _____.
- Diseases caused by an undersupply of nutrients are called _____ diseases. Deficiency means "_____".
- Deficiency diseases can be _____ and _____.
- _____ is better than treatment.
- For good health, a person should _____.
- Citrus fruits are a good source of _____.
- A good food source for vitamin D is _____.
- Good sources of the B vitamins are _____.
- Two important "bone minerals" are _____ and _____.

WORD SEARCH The words in this list are hidden within the group of letters in the box. Try to find each word. When you find it, draw a line around the word. The spelling may go in any direction.

SCURVY
RICKETS
BONES
TEETH
BERIBERI
PELLAGRA
DEFICIENCY
CITRUS
LIMES
ORANGES

W	R	I	L	M	R	A	S	T	Y	Y	W
V	B	S	S	U	R	S	N	E	X	V	O
S	O	L	E	C	T	L	I	M	T	R	L
P	O	N	P	G	I	F	R	I	U	U	Y
O	U	O	B	O	N	E	S	S	T	C	Y
N	O	B	I	E	A	A	U	O	N	S	C
L	N	I	A	C	I	N	R	E	I	Z	S
I	P	P	L	D	M	C	I	O	S	X	O
R	E	S	R	I	L	C	C	E	U	W	I
E	L	A	E	F	I	R	K	I	R	U	R
B	L	R	B	F	M	T	E	E	T	H	H
I	A	T	E	E	E	B	T	E	I	U	E
R	G	D	R	N	S	E	S	M	C	R	E
E	R	U	E	L	S	N	L	I	N	S	T
B	A	V	A	K	E	E	S	R	P	T	T

REACHING OUT

Some rice is "polished." Polishing removes most of the B vitamins.

The people of eastern Asia eat mostly "polished" rice. Many of these people eat only polished rice. These people were the first to develop beriberi.

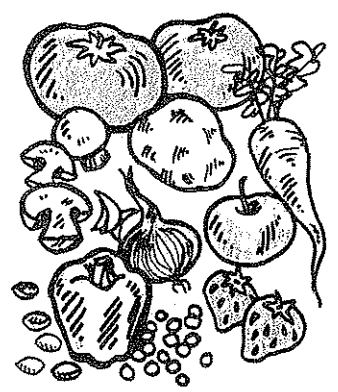
Now think of this. People of Europe also ate polished rice and "processed" grains. Yet, they developed fewer cases of beriberi than eastern Asians did. Why?

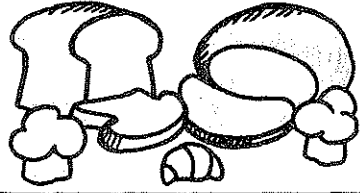
WHAT IS A "BALANCED" DIET?



11







nutritionist: a person who studies the value of food in a diet

AIM | What is a "balanced" diet?

11

Many people overeat. Yet they are poorly fed. Eating a lot does not always mean that we are eating properly.

A diet must be "balanced." This means that it must supply proper amounts of all the nutrients. People who study the value of nutrients in a diet are called nutritionists [new TRISH uh nists].

Foods can be divided into four groups. The four groups are:

MILK GROUP

This food group includes milk and milk products. Cheese, butter, and yogurt are examples of milk products.

BREAD AND CEREAL GROUP

This food group includes whole grain or enriched grain products. Bread, cereal, rice, crackers, and pastas are examples of foods in this group.

MEAT AND EGG GROUP

This food group includes meat, fowl, fish, and eggs. Nuts, peas, and beans that are high in protein are also included in this group.

VEGETABLE AND FRUIT GROUP

This food group includes green and yellow vegetables, citrus fruits, tomatoes, bananas, and raisins.

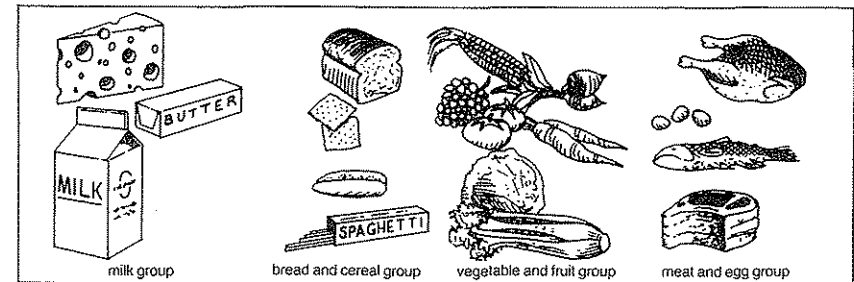
You should eat four or more servings from each food group each day. The total number of servings you eat from each group is called your daily intake.

Every meal should include at least one animal protein. Animal proteins include eggs, meat, fish, fowl, and milk products. At least one citrus fruit should be eaten every day.

Take advantage of what you have learned. Learn to choose foods wisely from these groups. Then you will be sure of having a balanced diet. Eating properly is an important key to good health.

THE FOUR FOOD GROUPS

Fill in the chart below with four specific examples of foods that belong in each food group.



	MILK GROUP	MEAT AND EGG GROUP	FRUIT AND VEGETABLE GROUP	BREAD AND CEREAL GROUP
1.				
2.				
3.				
4.				

COMPLETING SENTENCES

Complete the sentences with the words below.

meat and egg group vegetable and fruit group milk group
calcium nutrients protein
D bread and cereal group nutritionist

- The useful things we get from food are called _____.
- A person who studies the value of nutrients is called a _____.
- Foods can be placed into four groups. They are the _____, the _____, the _____, and the _____.
- Nuts and beans are part of the meat group because they are high in _____.
- The milk group supplies us with proteins, vitamins, minerals, and fats. It is especially rich in vitamin _____ and the mineral _____.

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

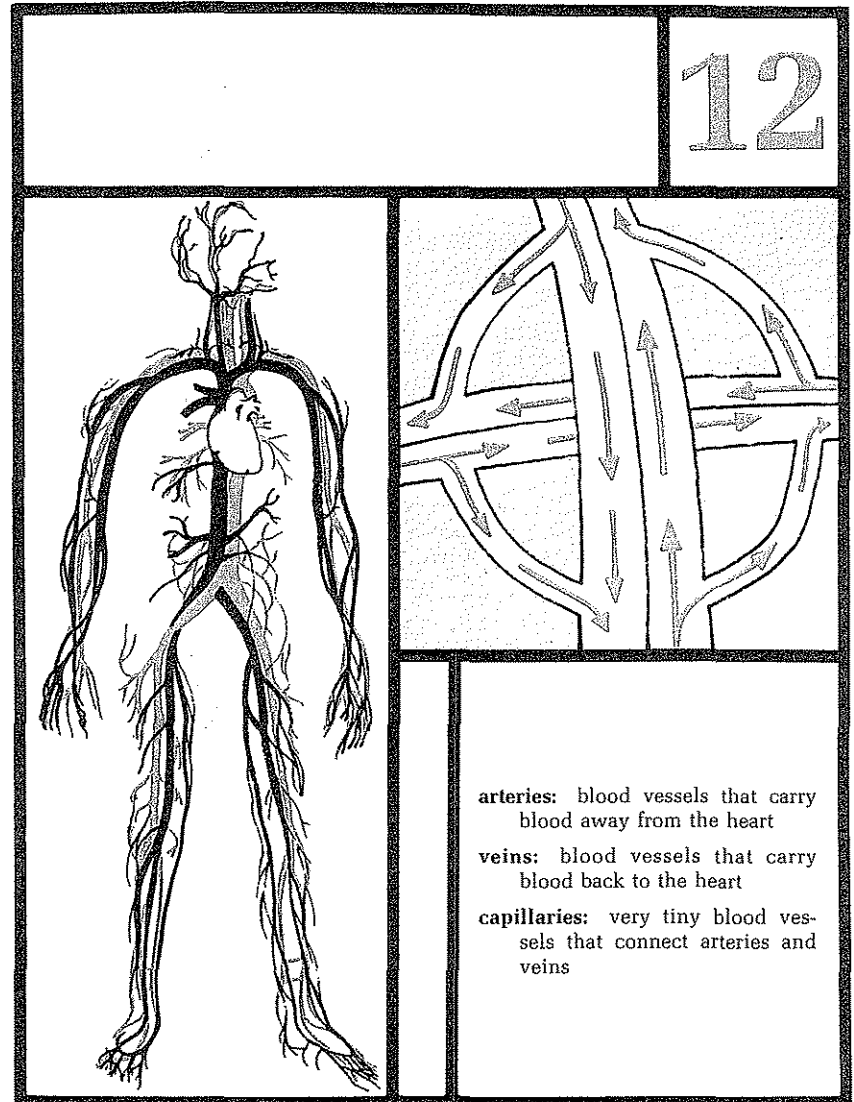
1. _____ A person who eats a lot always has a balanced diet.
2. _____ A balanced diet supplies the right amounts of all the nutrients.
3. _____ A person who eats only meat has a balanced diet.
4. _____ Eggs can take the place of meat in the diet.
5. _____ Bread and cereals supply animal protein.
6. _____ Vegetables are high in vitamin C.
7. _____ White bread supplies the same nutrients as citrus fruits.
8. _____ Ice cream contains milk.
9. _____ Nutritionists study the value of nutrients in the diet.
10. _____ How we eat can affect our health.

REACHING OUT Use what you have learned to plan three well balanced meals: breakfast, lunch, and supper. List the foods that you would include in each meal in the spaces below. Remember to include at least one animal protein in each meal.

[illegible]

WHAT IS THE BLOOD CIRCULATORY SYSTEM?

12



AIM | What is the blood circulatory system?

12

Can you imagine a messenger making trillions of stops in just thirty seconds? Your blood does!

Blood is an important body messenger. It is on the move day and night.

In just about thirty seconds, your blood moves (circulates) through your entire body. It reaches out to every one of your trillions of cells.

Blood *transports* (carries) to the cells all the things they need—like oxygen and digested nutrients. The cells take in, or *absorb*, these materials. In exchange, the blood picks up waste materials, from the cells. Waste materials include carbon dioxide, heat, and extra water.

Blood is pumped throughout the body by the heart. It flows in tubes called **blood vessels** [VES els]. Your body has three main types of blood vessels: **arteries** [AR tur ees], **veins**, and **capillaries** [KAP ih lair ees].

▪ **ARTERIES** carry blood away from the heart. Blood in the arteries is rich in oxygen and nutrients. Arteries carry the materials the cells need.

▪ **VEINS** carry blood from the body (cells) back to the heart. Blood in the veins carries dissolved waste materials.

▪ **CAPILLARIES** connect arteries and veins. Capillaries are very tiny. You need a microscope to see them. Most of the blood vessels in your body are capillaries.

Blood vessels branch into almost every part of the body. Hair and nails are parts of the body that do not have blood vessels. However, hair and nails do depend on blood for their oxygen and nutrients.

The heart, blood vessels, and blood make up the **blood circulatory** [SUR kyuh luh tohr ee] **system**. Circulation, or transport, is a vital function. Life cannot go on without it.

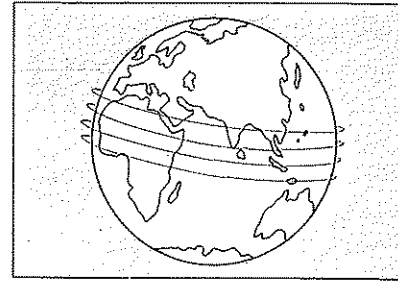


Figure A

BLOOD VESSELS

Blood vessels are found in almost every part of the body.

If laid end to end, your blood vessels would stretch out to about 161,000 kilometers (100,000 miles)!

That's about 4 times the distance around the equator!

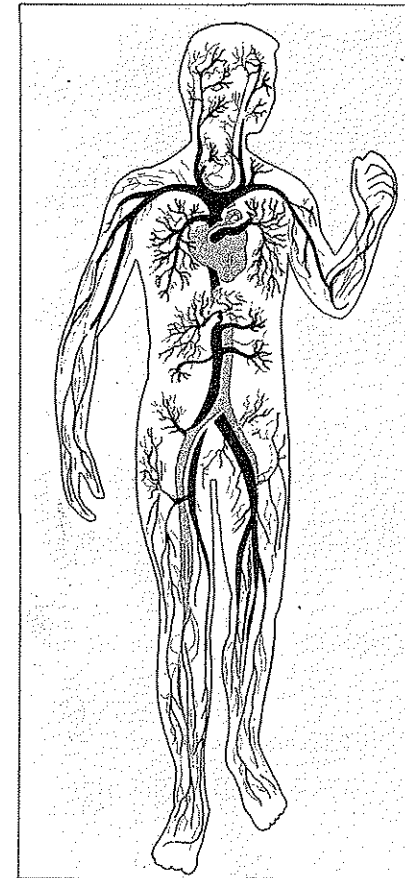


Figure B

Look at Figure B. The tubes in color show the arteries. The black tubes show the veins. Many thousands of tiny capillaries connect the arteries and the veins.

Write the correct term in each blank to answer the questions or complete the sentence.

1. What pumps blood through your body? _____
2. Vessels that carry blood away from the heart are called _____.
3. Vessels that carry blood back to the heart are called _____.
4. Blood moves from arteries to veins through tiny blood vessels called _____.
5. About how many times a minute does blood circulate through your body? _____
6. Two parts of the body that are not fed *directly* by blood vessels are the _____ and _____.

ARTERIES, VEINS, OR CAPILLARIES?

Look at Figure C. Then answer these questions:

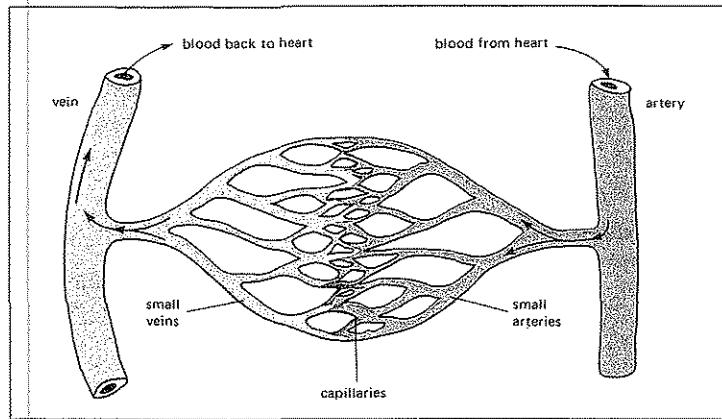


Figure C

1. Arteries branching away from the heart become _____
smaller and smaller, larger and larger
2. Veins leading back to the heart become _____
smaller and smaller, larger and larger
3. Most of our blood vessels are _____
arteries, veins, capillaries

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | | |
|----------|-------------|--|
| 1. _____ | circulation | a) carry blood away from the heart |
| 2. _____ | heart | b) pumps blood |
| 3. _____ | arteries | c) connect arteries and veins |
| 4. _____ | veins | d) transport of materials in living things |
| 5. _____ | capillaries | e) carry blood back to the heart |

COMPLETING SENTENCES Complete the sentences with the choices below. Three of these may be used twice.

heart
capillaries
digested food
veins

circulation
arteries
waste materials

oxygen
blood vessel
blood

1. The moving of materials in living things is called _____.
2. In humans, circulation is carried out by the liquid called _____.
3. Blood is pumped by the _____.
4. Blood brings to cells things like _____ and _____.
5. Blood picks up _____ from the cells.
6. Any tube that carries blood is called a _____.
7. The three kinds of blood vessels are _____, _____, and _____.
8. Blood is carried away from the heart by _____.
9. Blood is carried back to the heart by _____.
10. Arteries and veins are connected by tiny blood vessels called _____.

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

1. UCATLOCNIRI _____
2. NIVE _____
3. ILYCARLAP _____
4. THERA _____
5. RATYER _____

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Circulation is the transport of materials in living things.
2. _____ Life stops when circulation stops.
3. _____ Blood is pumped by the brain.
4. _____ Blood circulates through the body only a few times a day.
5. _____ Arteries carry blood away from the heart.
6. _____ Arteries transport carbon dioxide to the cells.
7. _____ Veins carry blood away from the heart.
8. _____ Veins pick up waste materials from the cells.
9. _____ Capillaries connect arteries and veins.
10. _____ Capillaries are the largest blood vessels.

REACHING OUT Circulation is always carried out by a *liquid*. In humans and many other animals, that liquid is *blood*.

What liquid carries out circulation in plants? _____

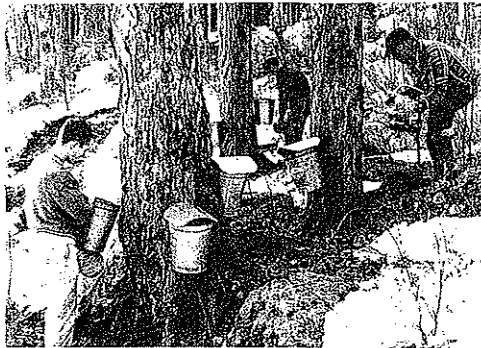
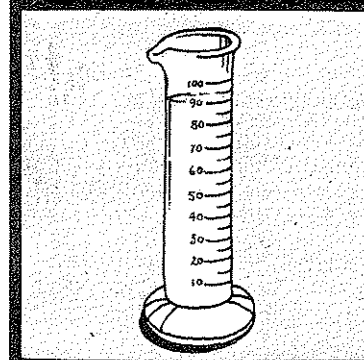
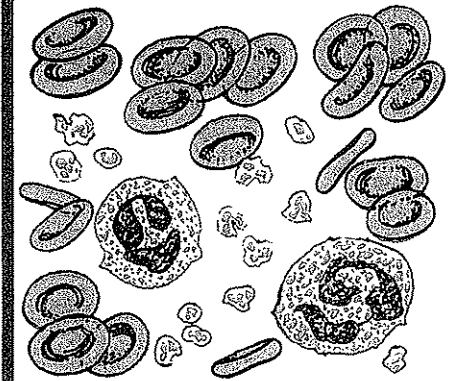
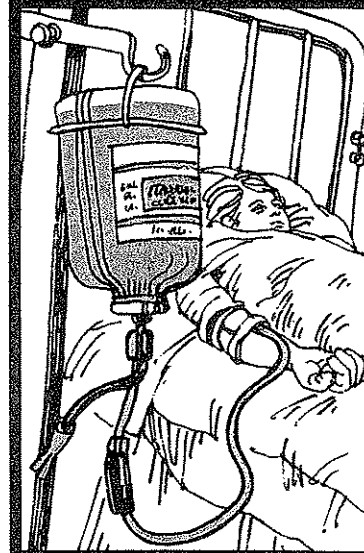


Figure D

WHAT IS BLOOD MADE OF?

13



plasma: the liquid part of blood
red blood cells: blood cells that carry oxygen
white blood cells: blood cells that fight infection
platelets: blood cells that help stop bleeding
hemoglobin: a substance in red blood cells that links up with oxygen

AIM 13 | What is blood made of?

In first aid, you learn how to help people who are hurt. An important first-aid rule is: "Treat Serious Bleeding First." A person can die very quickly from a loss of blood.

What is blood made of? Why is it so important to life?

Blood is the tissue of transport in your body. It carries needed materials to the cells. It also carries waste materials away from the cells.

Blood has a liquid part and a solid part. The liquid part of blood is called *plasma* [PLAZ muh]. The solid part of blood is made up of *blood cells*.

PLASMA

Plasma is 90% water. It is straw-like in color. Digested food, important chemicals, and certain waste products are dissolved in plasma. These substances are carried to the cells by the plasma. The waste materials are carried away from the cells.

BLOOD CELLS

Your blood is made up of three kinds of blood cells: red blood cells, white blood cells, and platelets. These blood cells are carried in the flowing plasma.

■ Red blood cells contain a substance called hemoglobin [HEE muh globe in]. Hemoglobin is red. It gives blood its color.

Oxygen links up with hemoglobin. Red blood cells carry this oxygen to all parts of the body. The same hemoglobin also picks up most of the carbon dioxide waste that is made by the cells.

■ White blood cells fight disease and infection. They destroy harmful germs in the body.

■ Platelets help stop bleeding. They give off a chemical that helps blood clot.

BLOOD COMPOSITION

Figure A shows the composition of blood. Study Figure A. Then answer the questions.

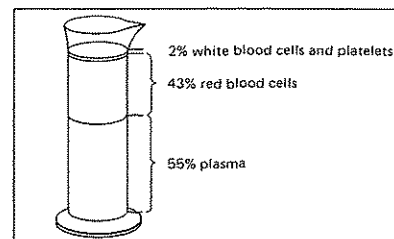


Figure A What blood is made of.

1. What percent of blood is liquid?

2. What is the name of the liquid part of blood?

3. a) The liquid part of blood is made up mostly of _____
(If you need help, look back to the reading.)

b) What percent?

4. All of the blood cells together make up _____ percent of blood.

5. Red blood cells make up _____ percent of blood; white blood cells make up _____ percent.

6. What percent of blood is made up of platelets?

BLOOD CELLS—THEIR SIZES AND NUMBERS

Figure B will give you an idea of the sizes and numbers of blood cells found in your body. Study Figure B. Then answer the questions.

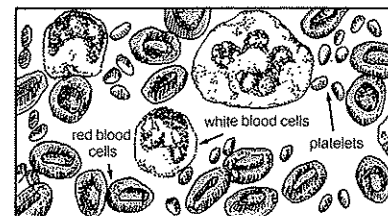


Figure B

1. Which blood cells are the largest?

2. Which blood cells are the smallest?

3. a) Which type of blood cell is most numerous?

b) Which type of blood cell is least numerous?

4. Which cells are shaped like "pinched" disks?

Look at Figure C. Then answer the question.

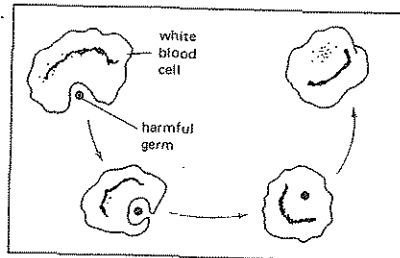


Figure C A white blood cell at work.

5. Describe briefly what is happening in Figure C. _____

Look at Figure D. Then answer the questions.

6. When you cut yourself, which part of the blood helps you stop bleeding?

7. White blood cells also come to the area of a cut. Why? _____
8. Take a guess! What happens to the number of *white blood cells* when germs are in the body? _____

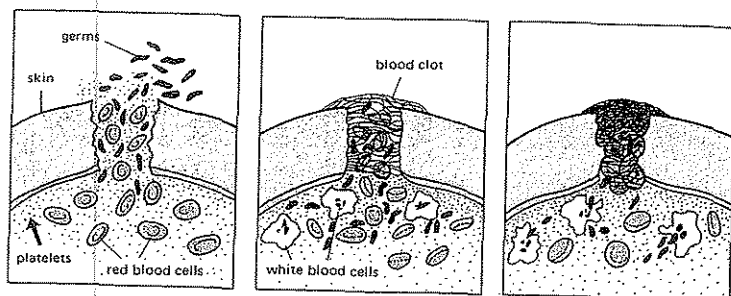


Figure D Blood clots when your skin is cut.

NAMING THE PARTS OF BLOOD

Name the part or parts of blood that:

- | | |
|----------------------------------|-------------------------------------|
| 1. is 90 percent water _____ | 7. are most numerous _____ |
| 2. attracts oxygen _____ | 8. help stop bleeding _____ |
| 3. attracts carbon dioxide _____ | 9. fight infection _____ |
| 4. is largest in size _____ | 10. carries the blood cells _____ |
| 5. is smallest in size _____ | 11. is straw-like in color _____ |
| 6. are fewest in number _____ | 12. gives blood its red color _____ |

TO OR AWAY? Blood has been called the "River of Life." Blood carries to the cells materials the cells need. In turn, blood carries away waste materials made by the cells.

- I. Ten substances carried by the blood are listed in the chart below. Indicate whether each substance is carried *to the cells* or *away from the cells*. Place a check (✓) in the proper boxes.

	SUBSTANCE CARRIED BY THE BLOOD	CARRIED TO THE CELLS	CARRIED AWAY FROM THE CELLS
1.	digested food		
2.	oxygen		
3.	carbon dioxide		
4.	enzymes		
5.	hormones (used by the cells to regulate chemical reactions)		
6.	heat		
7.	harmful chemicals		
8.	extra (waste) water		
9.	vitamins and minerals		
10.	proteins		

II. Answer the following questions about oxygen and carbon dioxide.

OXYGEN

1. Oxygen is needed by the cells, a cell waste
2. Which blood cells pick up and carry oxygen? red blood cells,
white blood cells, platelets
3. What substance in red blood cells attracts oxygen? _____
4. Where does the blood pick up this oxygen? _____
 - a) in the heart
 - b) in the arteries and veins
 - c) in the lungs
5. What carries the oxygen to the cells? _____

CARBON DIOXIDE

6. Carbon dioxide is needed by the cells, a cell waste
7. a) Which blood cells pick up the most of the carbon dioxide from the cells?
red blood cells, white blood cells, platelets
b) What specific substance in these cells attracts carbon dioxide?

8. Where does the blood release this carbon dioxide? _____
 - a) in the heart
 - b) in the lungs
9. Finally, what happens to this carbon dioxide? (Hint: Think of what you do to get rid of carbon dioxide.) _____
10. a) What living things need carbon dioxide to carry out an important life function? _____
b) Why do these organisms need this carbon dioxide? _____

SOME INTERESTING FACTS ABOUT BLOOD

1. Blood makes up about 9% of a person's body weight. For example, if you weigh 100 pounds, 9 pounds is blood. (Figure out how many pounds of blood your body has.)
2. An adult has about 12 pints of blood.

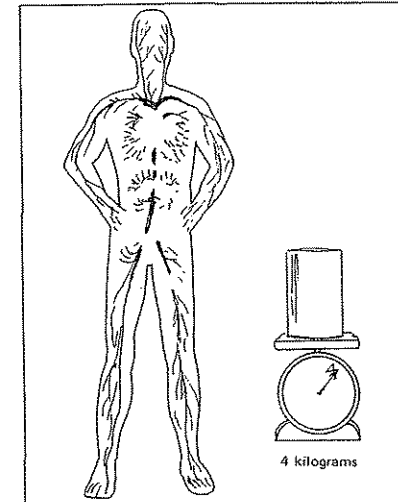


Figure E Blood makes up about 9% of a person's weight. If you weigh 45 kilograms (100 pounds), 4 kilograms (9 pounds) is blood.

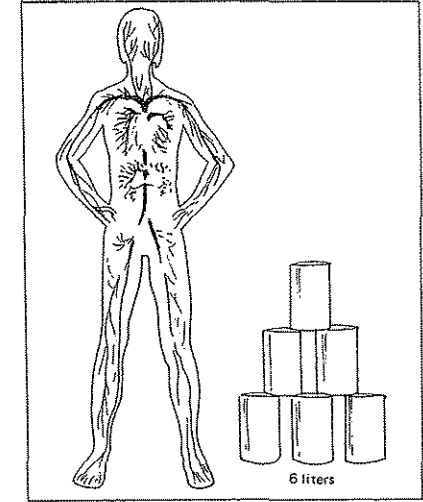


Figure F A grownup has about 5.7 liters (12 pints) of blood.

3. There are about 600 red blood cells for every white blood cell in your blood. Just one drop of blood contains about 5 million red blood cells. There are about 25 trillion red blood cells in the body of the average adult.
4. Red blood cells and white blood cells are produced in the marrow of bones—especially in the ribs, breast bone, and backbone.
5. It is estimated that from 1 to 2 million red blood cells die every second. New cells are made to take their place.
6. Blood cells are carried by the flowing plasma. White blood cells, however, can also move by themselves.

White cells can also pass through tiny holes in the blood vessels. They move into surrounding tissues.

White blood cells are like good soldiers. They seek out and destroy enemies (harmful germs).

KEEPING UP WITH SCIENCE

BIONIC BLOOD

A very important job of blood is to carry oxygen to the cells of the body.

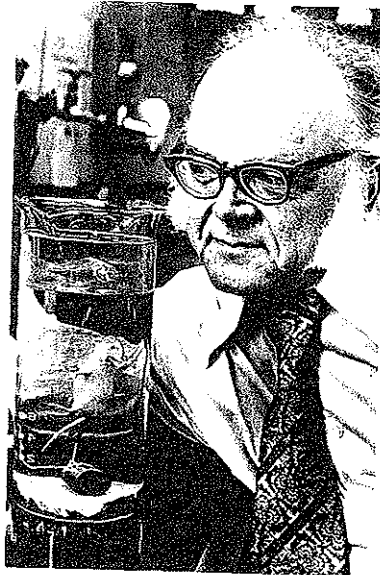
Scientists have discovered that a liquid called fluorocarbon dissolves a great deal of oxygen. In fact, it carries more than three times more oxygen than blood does. This white liquid is chemically related to Teflon, which coats cooking pans.

How could this property of fluorocarbon be put to use? In 1966 a scientist named Leland C. Clark Jr. had a hunch. He filled a beaker with a liquid fluorocarbon and pumped oxygen into it. Then he submerged a mouse into the liquid. At first, the mouse was frantic. Who wouldn't be? It had liquid in its lungs. Then it calmed down! The air sacs of the lungs were absorbing the oxygen from the fluorocarbon. And the fluorocarbon was absorbing carbon dioxide from the walls of the air sacs.

The mouse stayed in the liquid for several hours. Then it was removed from the beaker and examined. The mouse was in fine health. It continued doing everything a mouse is supposed to do.

The experiment showed that the fluorocarbon carried enough usable oxygen to support life. It was also not poisonous, and it caused no lung damage.

Clark wondered if the liquid could be used as an artificial blood. He did many experiments with the liquid. They showed that fluorocarbons alone could carry oxygen and remove carbon dioxide as well as real blood does. But real blood does more. It does things that fluorocarbons cannot do well. Real blood carries nutrients, impor-



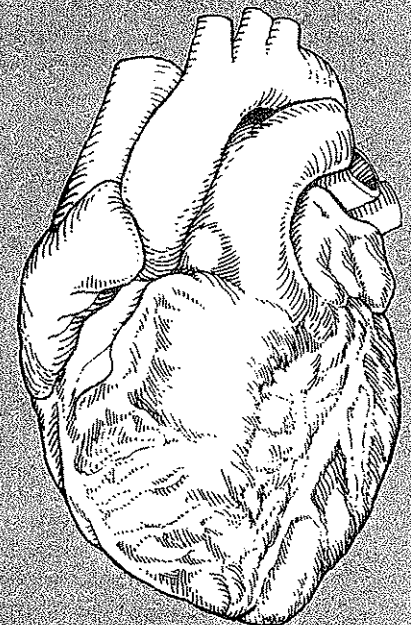
tant chemicals, and wastes other than carbon dioxide. It carries disease-fighting white cells as well as clot-forming platelets.

It is clear that artificial blood cannot be a complete blood substitute. However, it can be very valuable as a partial blood substitute. Fluorocarbons may be used for transfusions and for special medical needs. It can be stored frozen for three years, compared to five weeks for red blood cells.

Fluorocarbons have been used successfully in people. But so far only a few. Several problems must be solved before "bionic blood" is more widely used. However, the answer to these problems seem not too far in the future.

HOW DOES YOUR HEART WORK?

14



atria: the two upper spaces, or chambers, of the heart

ventricles: the two lower spaces, or chambers, of the heart

valve: a movable part that can either stop a gas or liquid or let it pass

AIM | How does your heart work?

14

Place your hand on your chest. The beating you feel is from your heart. It is keeping you alive.

Your heart is mostly muscle tissue. It has only one job. Day and night, twenty-four hours a day, your heart pumps blood to every part of your body.

The human heart is divided into four separate spaces called chambers. Two chambers are in the upper part of the heart; two chambers are in the lower part.

ATRIA [AY tree uh]

The upper chambers of the heart are the right and left atria (singular atrium). ATRIA RECEIVE BLOOD.

■ The right atrium receives blood from all parts of the body. Blood in the right atrium is "stale." It is high in carbon dioxide and low in oxygen.

■ The left atrium receives "fresh" blood from the lungs. Blood in the left atrium is high in oxygen and low in carbon dioxide.

Both atria fill with blood at the same time.

VENTRICLES [VEN trik uls]

The lower chambers of the heart are the ventricles. VENTRICLES PUMP BLOOD OUT OF THE HEART.

■ The right ventricle pumps "stale" blood to the lungs. This blood is high in carbon dioxide and low in oxygen. When the blood is in the lungs, it gives up its carbon dioxide. Then, the blood picks up fresh oxygen.

■ The left ventricle pumps "fresh" blood to all parts of the body. Blood in the left ventricle is high in oxygen. It is low in carbon dioxide.

Both ventricles pump blood out of the heart at the same time. Every time your heart beats, blood is being "squeezed" out of the ventricles.

Blood moves in only one direction. The heart (and veins) has valves that keep the blood from flowing backward.

A muscular wall divides the right side of the heart from the left side. This wall is called the septum. Blood cannot flow from one side of the heart to the other.

HOW YOUR HEART WORKS

The human heart is like two separate pumping systems. One system serves the lungs. The other, serves the entire body.

Let's trace the path of blood into and out of the heart. NOTE: The heart diagrams are shown as if you were looking at the front of a person. The right side of the heart appears on the left side of the drawings. The left side of the heart appears on the right.

REMEMBER: In a working heart, both upper chambers fill with blood at the same time. Both lower chambers squeeze (pump blood out) at the same time.

We will study the left side of the heart first. Then, we will study the right side of the heart. In this way, you will better understand how the blood circulatory system works.

1. VEINS CARRY BLOOD FROM ALL PARTS OF THE BODY TO THE HEART.

Answer the questions below. Search the reading and study the diagrams carefully to find the answers.

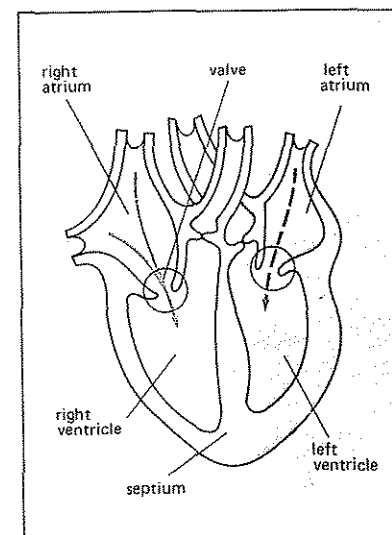


Figure A

1. Which chamber collects blood from the veins? _____

2. a) The blood passes from this chamber into the _____

b) While this is happening, the valve between the right atrium and right ventricle is _____
open, closed

3. The blood in the right ventricle is _____ blood. It is high in _____, and low in _____
fresh, stale
oxygen, carbon dioxide
oxygen, carbon dioxide

4. The body _____ use this blood.
can, cannot

5. Where must this blood go to be made fresh again? _____

II. THE RIGHT VENTRICLE CONTRACTS. IT SQUEEZES ITS BLOOD OUT OF THE HEART.

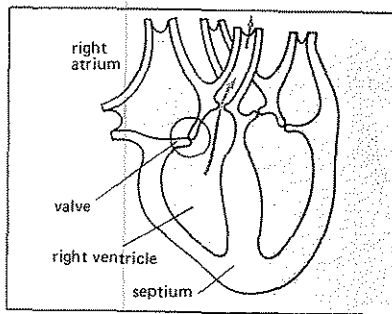


Figure B

6. a) When the right ventricle contracts, the valve between the upper and lower chambers is

_____ open, closed _____

- b) What does this prevent? _____

7. Blood pumped out of the right ventricle goes _____ to the body, to the lungs
8. In the lungs, the blood gives up its _____ oxygen, carbon dioxide, and picks up _____ oxygen, carbon dioxide
9. The blood is now _____ stale, fresh. It _____ can, cannot be used by the cells.
10. Where must the blood go before it can be sent to the entire body? _____

III. VEINS CARRY FRESH BLOOD BACK TO THE HEART.

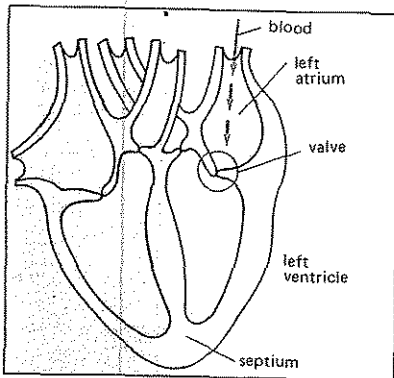


Figure C

100

11. Which chamber collects this blood?

_____ left atrium, left ventricle _____

12. a) The blood then passes into the

_____ left atrium, left ventricle _____

- b) While this is happening, the valve between the left chambers is

_____ open, closed _____

IV. THE LEFT VENTRICLE CONTRACTS. THIS FORCES BLOOD OUT OF THE HEART.

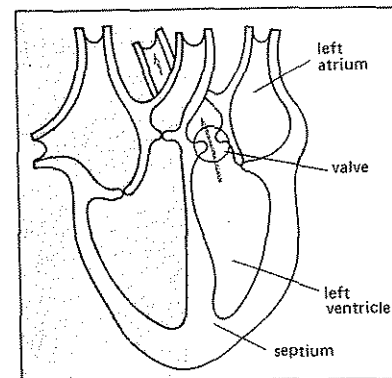


Figure D

13. a) When the left ventricle contracts, the valve between the left chambers is _____ open, closed _____

- b) Why? _____

14. Where does blood leaving the left ventricle go? _____

15. THEN, what do you think happens to the blood? _____

WHAT IS A PULSE?

Every time your ventricles contract, blood is forced suddenly out of your heart and into your arteries. This sudden force makes your arteries jump. This movement of your arteries is called a pulse.

Each pulse beat tells you that your ventricles are contracting.

PULSE BEAT = HEARTBEAT

How fast does your heart beat? It depends on several things—like age, activity, and how calm or excited you are.

The heart of a rested adult beats 70 to 80 times a minute. A young person's heart beats slightly faster.

Activity, fear, worry, and excitement are all things that make the heart beat faster.

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FEEL YOUR PULSE

You can feel a pulse on an artery that is near the skin.

Each pulsebeat tells us that blood is being pumped out of the heart.

There are several pulse spots. Most pulses are taken on the wrist. Figure E shows how to do it. See if you can feel your pulse. (Do not use your thumb.)

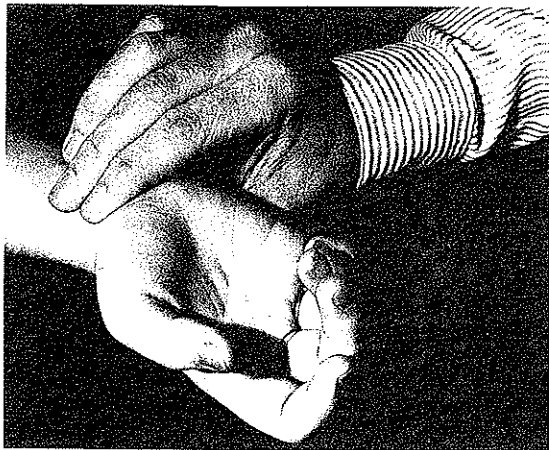


Figure E

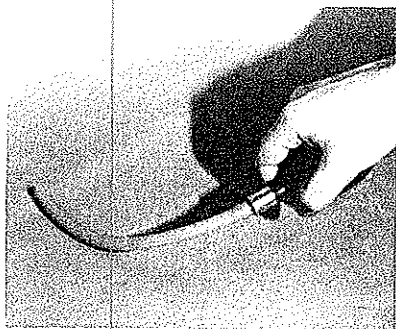


Figure F

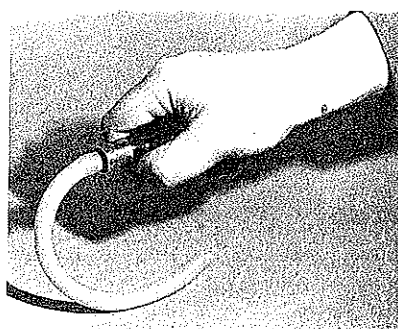


Figure G

You can get an idea how a pulse works.

Squeeze a rubber bulb filled with water. The tube connected to it will "jump." This "jump" is like a single pulsebeat.

TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ The heart is a muscle.
2. _____ The heart has many jobs.
3. _____ A human heart has four chambers.
4. _____ Heart chambers are called arteries and veins.
5. _____ Blood moves from the atria to the ventricles.
6. _____ Ventricles receive blood from veins.
7. _____ Arteries carry blood away from the heart.
8. _____ The right and left ventricles pump at the same time.
9. _____ Your heart stops beating when you are asleep.
10. _____ Your heart beats millions of times a year.

SPELL THE MISSING WORD Fill in the missing letters to spell the terms that fit the definitions. When you have answered correctly, you will spell another term in the box.

- | | | | | | | |
|----|---|---|---|---|---|---|
| 1. | | e | | s | | l |
| 2. | | t | | i | | m |
| 3. | | e | | t | | |
| 4. | | e | | t | | i |
| 5. | h | | a | | t | |

1. carries blood
2. top chamber of the heart
3. not the right side
4. bottom chamber of the heart
5. pumps blood

REACHING OUT RESEARCH

1. Arteries carry "fresh" blood. There is one exception. Which artery is the exception? _____
2. Veins carry "stale" blood. There is one exception. Which vein is the exception? _____

(Hint: Study the heart diagrams very carefully.)

EXPERIMENT

Purpose:

To find out about pulse rates.

Take your own pulse rate. Then take the pulse of four classmates.

What to do:

Take each pulse before exercise; then after exercise. (Exercise by running in place for thirty seconds.)

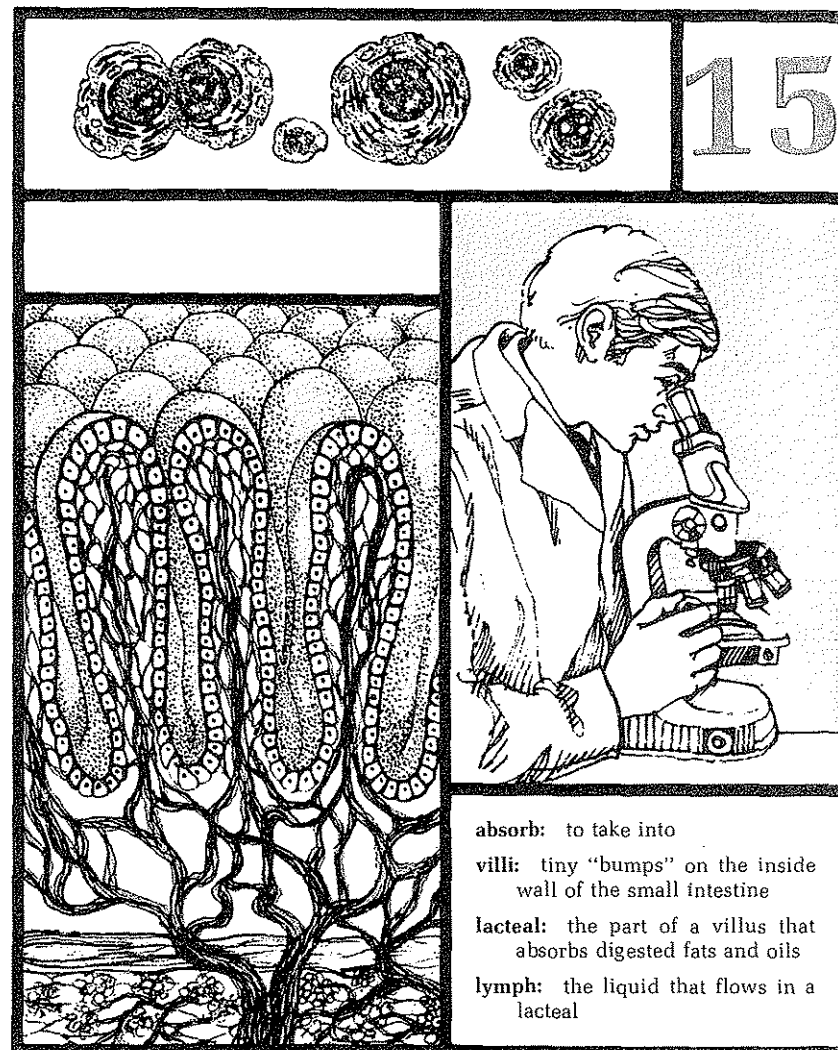
Fill in your results.

	Name	Test #1 Rested Pulse Rate	Test #2 Pulse Rate After Exercise
1.			
2.			
3.			
4.			
5.			
	Totals		
	AVERAGES (Add all the pulses in each test group. Then divide by 5).		

Conclusions:

1. Everyone's pulse rate _____ the same.
is, is not
2. Exercise makes the pulse beat _____.
slower, faster

HOW DOES DIGESTED FOOD REACH THE CELLS?



absorb: to take into

villi: tiny "bumps" on the inside wall of the small intestine

lacteal: the part of a villus that absorbs digested fats and oils

lymph: the liquid that flows in a lacteal

AIM | How does digested food reach 15 | the cells?

You have learned how food is digested. You know that digestion is completed in the small intestine. But, digested food has no value unless it gets into your cells.

How does digested food leave the small intestine? And, how does it reach your cells?

This is how it happens:

The inner wall of the small intestine is lined with thousands of tiny "bumps." These bumps are called villi [VIL eye]. (One bump is called a villus.)

Each villus has two kinds of tubes:

1. a network of capillaries, and
2. a lacteal.

As you know, capillaries carry blood. The lacteals carry a liquid called lymph.

Digested food surrounds each villus. The food leaves the small intestine through the capillaries and lacteals.

- The lacteals absorb digested fats and oils.
- The capillaries absorb all other nutrients.

Lymph and blood flow through the body in separate tubes. But the two liquids do not stay separated. Lymph empties into the bloodstream near the heart. Then, the blood carries all the nutrients.

As you know, blood goes to every part of the body. The cells absorb the nutrients from the blood.

UNDERSTANDING ABSORPTION IN THE SMALL INTESTINE

Study Figures A and B.

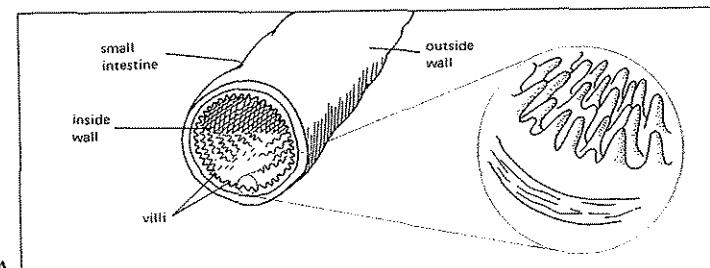


Figure A

The inner wall of the small intestine has thousands of tiny villi.

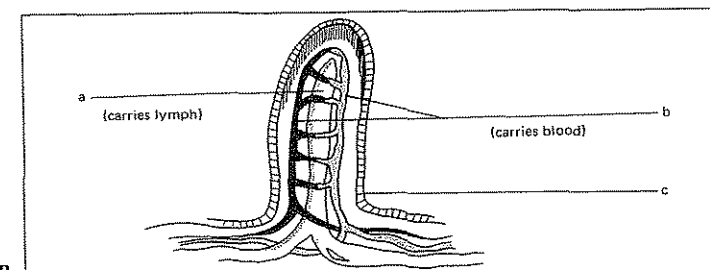


Figure B

a single villus

1. Label the parts of a villus. Use the words below to fill in the blank lines in Figure B.

capillaries lacteal villus wall

2. a) Digested fats and oils are absorbed by the _____.
capillaries, lacteals
- b) Digested starches, sugars, and proteins are absorbed by the _____.
capillaries, lacteals
3. Digested food is carried to all parts of the body by the _____.
blood, small intestine
4. Then, what happens to the digested food? _____

MORE ABOUT LYMPH

Lymph absorbs digested fats and oils in the small intestine. This is important. But lymph does even more.

Without lymph, cells could not receive the things they need—like oxygen and *all* digested nutrients. The cells could not get rid of their wastes either. Without lymph, cells would die.

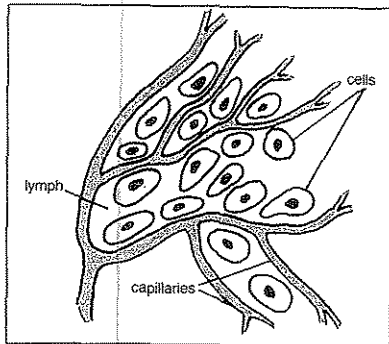


Figure C Lymph flows freely between the body's cells.

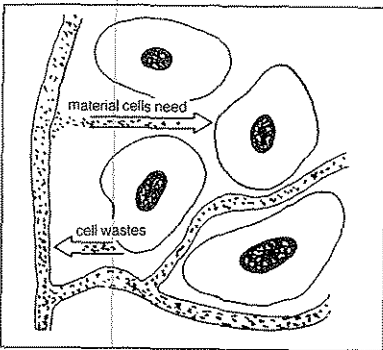


Figure D The movement of needed materials and wastes.

What does lymph do?

Lymph acts like a "middle man" between the blood system and the cells.

What is lymph?

Lymph is a straw-colored liquid. It comes from the blood. In fact, lymph is *almost* the same as blood plasma—only some substances are missing.

- Most capillaries come very close to cells. But they do not touch the cells.
- There are tiny spaces between the blood vessels and the cells.
- These spaces are filled with lymph.

Capillaries and cells are *always* exchanging materials. These materials must cross this lymph-filled gap.

THE LYMPH CYCLE

Figure E shows the lymph cycle. It shows where lymph begins and where it goes. Follow the explanations below the diagram.

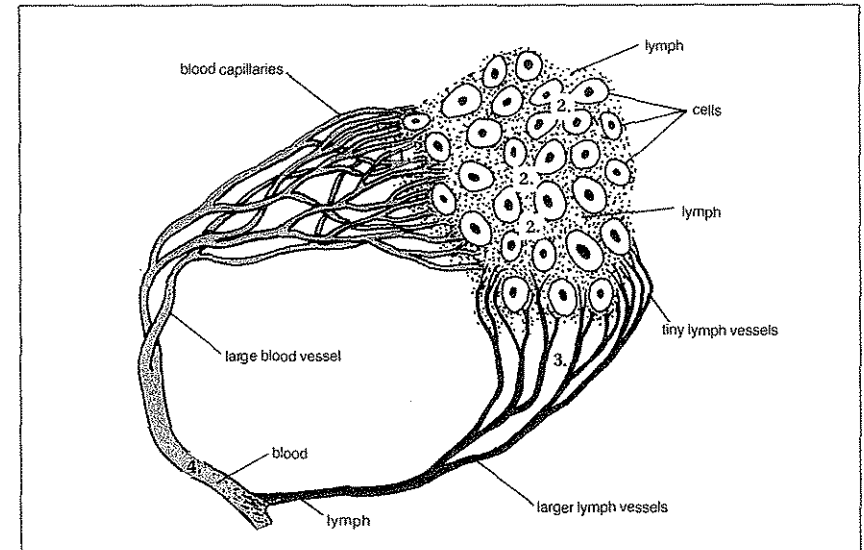


Figure E The lymph cycle.

1. Lymph forces its way out of the blood capillaries. It moves into surrounding tissues.
2. At this point, the lymph is not in tubes. It flows freely in the spaces between the cells.
3. The lymph collects. Then it flows into the lymph vessels.
4. The lymph vessels empty the lymph back into the bloodstream.

What do you think happens to the lymph next? _____

Humans (and many other animals) really have two circulatory systems:

- one blood circulatory system, and
- one lymph circulatory system.

CHOOSE ONE Answer the questions about lymph. Circle the correct answer.

1. Lymph is a (solid, liquid, gas).
2. The color of lymph is (green, red, straw-like).
3. In the small intestine, pure lymph is found in the (nutrients, capillaries, lacteals).
4. Lacteals absorb digested (sugars, fats and oils, proteins).
5. Most blood capillaries (do, do not) touch the cells.
6. The tiny spaces between cells are filled with (blood plasma, whole blood, lymph).
7. Lymph, found among the cells, moves (in the capillaries, freely, in vessels).
8. Lymph re-enters the bloodstream (in the small intestine, in the heart, near the heart).
9. Lymph is almost the same as (blood plasma, whole blood, straw).
10. We can say that humans have (one, two) circulatory systems.

The following is a list of substances found in the body. Answer the questions about these substances and lymph.

oxygen
extra water

carbon dioxide
digested food

extra heat

11. Which of these substances move from the lymph into the cells? _____

12. Which of these substances move from the cells into the lymph? _____

Circle the letter of the correct answer.

- [illegible]

COMPLETING SENTENCES Complete the sentences with the choices below. One of these is used twice.

mouth
lacteal
all digested nutrients
absorption

cells
small intestine
digestion
villi

fats and oils
nutrients
capillaries

1. Our bodies are made up of trillions of _____.
2. All the useful things we get from food are called _____.
3. The breaking down of food into simpler and smaller molecules is called _____.
4. Digestion starts in the _____ and is completed in the _____.
5. The taking in of a liquid by cells is called _____.
6. Absorption of food takes place through tiny "bumps" called _____.
7. Villi line the inner wall of the _____.
8. Every villus has _____ and a _____.
9. Lacteals absorb digested _____.
10. Capillaries in villi absorb _____ except fats and oils.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

1. _____ digestion
 2. _____ lymph
 3. _____ small intestine
 4. _____ lacteals
 5. _____ capillaries
- a) lined with villi
 - b) changes food to a form the body can use
 - c) absorb digested fats and oils
 - d) absorb all digested food except fats and oils
 - e) lacteal liquid

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Digestion changes food to a liquid.
2. _____ Digestion is completed in the small intestine.
3. _____ Most food absorption takes place in the stomach.
4. _____ Lacteals absorb digested fats and oils.
5. _____ Villi capillaries absorb only digested starches.

WORD SEARCH The words in this list are hidden within the group of letters in the box. Try to find each word. When you find it, draw a line around the word. The spelling may go in any direction.

LACTEALS
VILLI
LYMPH
BILE
RENNIN
PEPSIN
DIGESTION
INTESTINE
ABSORB
NUTRIENT

A	H	T	N	E	I	R	T	U	N
B	P	V	N	P	P	N	B	O	N
S	M	I	Y	E	M	S	I	L	I
O	Y	L	P	Y	E	T	L	A	N
R	L	S	E	L	S	P	E	C	N
B	I	N	T	E	S	T	I	N	E
N	R	B	G	A	R	Y	P	E	R
S	V	I	L	L	I	D	O	N	A
O	D	S	L	A	E	T	C	A	L

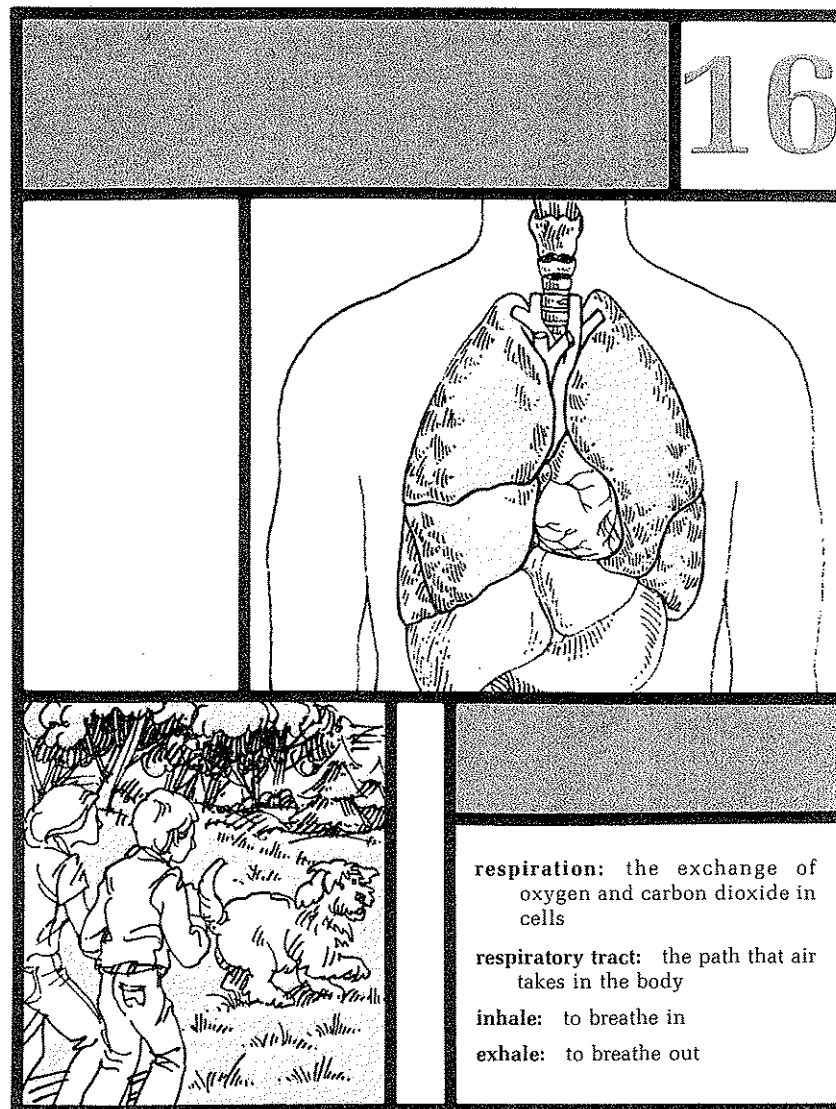
REACHING OUT

1. Which covers more surface area, a flat surface or a bumpy surface?

2. How does the shape of the villi speed absorption?

WHAT IS THE RESPIRATORY SYSTEM?

16



respiration: the exchange of oxygen and carbon dioxide in cells

respiratory tract: the path that air takes in the body

inhale: to breathe in

exhale: to breathe out

AIM | What is the respiratory system?

16

Almost every living thing must take in oxygen in order to live. Breathing is the process of bringing air into the lungs. Breathing also pushes out used air.

In humans and many other animals, breathing is done by means of lungs. The lungs, along with several other organs, make up the respiratory system.

Let us trace the path air takes when you *inhale* (breathe in). Check with Figures A and B as you read.

1. Air enters the body through the mouth or nose.
2. The air then passes through the windpipe, or *trachea* [TRAY kee uh].
3. The trachea branches into two tubes called *bronchi* [BRONG kie].
4. The bronchi branch into smaller and smaller tubes. They end up as millions of tiny *air sacs*. Each air sac is surrounded by *capillaries*.

Parts of the bronchi, its branching tubes, and the air sacs (alveoli) make up the lungs.

While the air is in the air sacs, two important things happen:

1. The blood picks up (absorbs) oxygen from the air sacs.
2. At the same time, the air sacs pick up carbon dioxide waste from the blood.

When you *exhale*, you breathe out the carbon dioxide. Some waste water and heat are also exhaled.

We see that the respiratory system and the blood system work together to keep us alive and healthy.

The actual use of oxygen by cells is called *respiration*.

ABOUT THE RESPIRATORY TRACT

The path that air follows when we breathe is called the *respiratory tract*. It is shown in Figure A. Study it. Then answer these questions or complete the sentences.

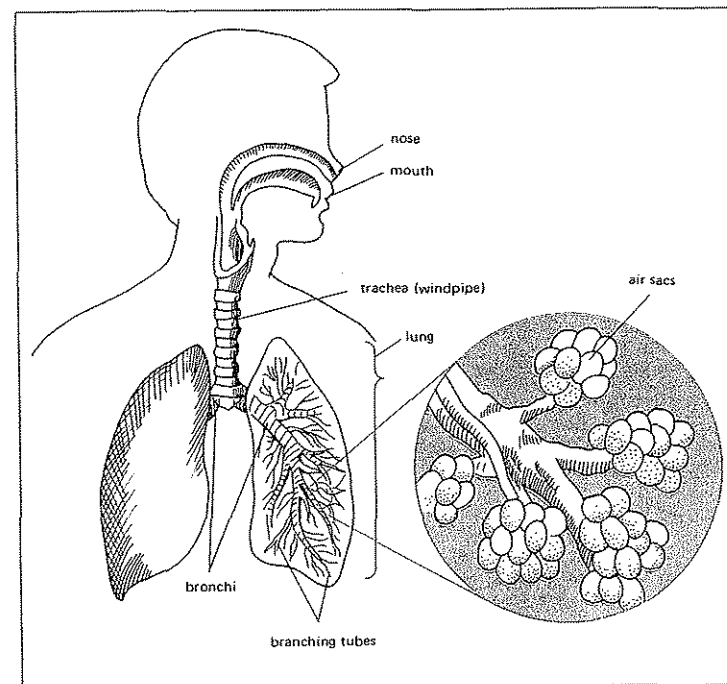
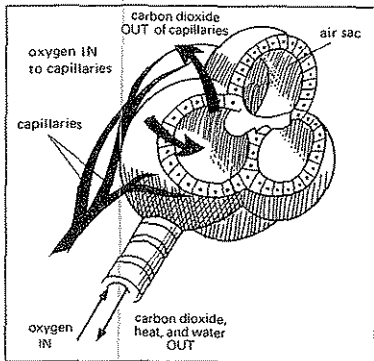


Figure A Notice the enlarged segment of the lung. Each small branch ends at an air sac.

1. The respiratory tract starts with the _____ and the _____.
2. The respiratory tract ends with millions of tiny _____.
3. How many lungs does a person usually have? _____
4. The parts of the respiratory tract are listed below. But they are not in order. Rewrite them in the order in which air goes through the body.
bronchi mouth and nose air sacs trachea branching tubes
_____, _____, _____, _____,
_____.
5. The voice box is on top of the trachea. Can you find it? Label the voice box on the diagram.



WHAT HAPPENS IN THE LUNGS?

The lungs have millions of air sacs. They are very tiny. You need a microscope to see them.

Figure B

1. Air that enters the air sacs is rich in _____.
oxygen, carbon dioxide
2. Air that leaves the air sacs is rich in the gas _____.
oxygen, carbon dioxide
3. Air sacs are surrounded by _____.
4. The capillaries around the air sacs take in _____ and give off _____.
oxygen, carbon dioxide
5. List the three waste materials the lungs excrete.
_____, _____, _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|----------------------|------------------------------|
| 1. _____ exhaling | a) where gases are exchanged |
| 2. _____ inhaling | b) windpipe |
| 3. _____ air sacs | c) breathing in |
| 4. _____ trachea | d) surround the air sacs |
| 5. _____ capillaries | e) breathing out |

COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used twice.

oxygen	windpipe	nose	inhaling
air sacs	bronchi	capillaries	mouth
carbon dioxide	exhale	smaller and smaller	

1. All living things need the gas _____.
2. Breathing in is called _____.
3. We inhale through the _____ or _____.
4. The trachea is the scientific name for the _____.
5. The trachea divides into two tubes called _____.
6. In the lungs, the tubes branch into _____ tubes.
7. The lungs have millions of tiny spaces called _____.
8. Air sacs have many _____.
9. Air sacs give _____ to the blood. The blood gives _____ to the air sacs.
10. We get rid of carbon dioxide waste when we _____.

LABEL THE DIAGRAM Identify the parts of the respiratory tract by letter.

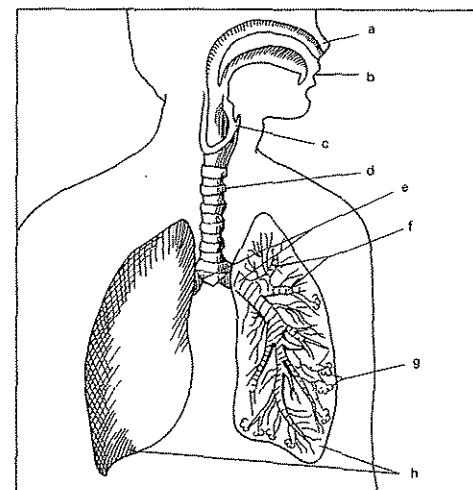


Figure C

1. bronchi _____
2. nose _____
3. branching tubes _____
4. voice box _____
5. mouth _____
6. air sacs _____
7. trachea _____
8. lung _____

BREATHING

Breathing and respiration are related. But they are not the same.

Respiration is a *chemical* process. It happens in every cell. In respiration, digested food links up with oxygen. This link-up produces the energy the cells need.

Breathing is a *mechanical* [muh KAN ih kul] action. Breathing is the movement of gases into and out of the lungs.

Breathing is *involuntary*. You do it automatically without thinking. You breathe all the time. You breathe when you are awake. You breathe when you are asleep. You even breathe when you are unconscious!

How does breathing take place?

Many people believe that air in the lungs makes their chest move in and out when they breathe. This is not true. In fact, the opposite is true. It is your *chest size* that makes air move in and out of your lungs.

Your chest size changes when you breathe. It changes because of the actions of:

- your rib muscles, and
- your diaphragm [DIE uh fram] muscle.

INHALING AND EXHALING Figures D and E show what happens when you breathe. Study the diagrams carefully. Then answer the questions.

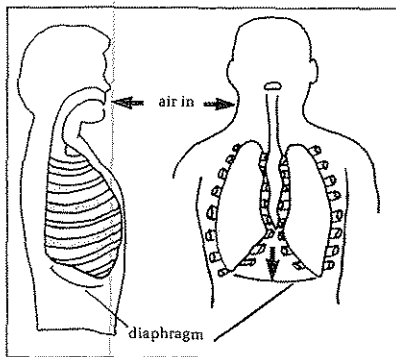


Figure D Inhaling

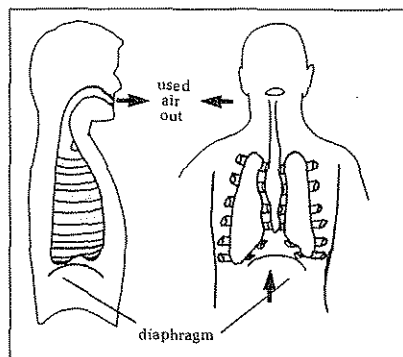


Figure E Exhaling

1. When you inhale (see Figure D),

- a) The ribs move _____
inward, outward
- b) the diaphragm moves _____
upward, downward
- c) There is now _____ space in the chest area.
more, less
- d) Air rushes _____ to fill this space.
in, out

2. When you exhale (Figure E),

- a) the ribs move _____
inward, outward
- b) the diaphragm moves _____
upward, downward
- c) There is now _____ space in the chest area.
more, less
- d) Because of this pressure, air moves _____ the lungs.
into, out of

MORE ABOUT BREATHING

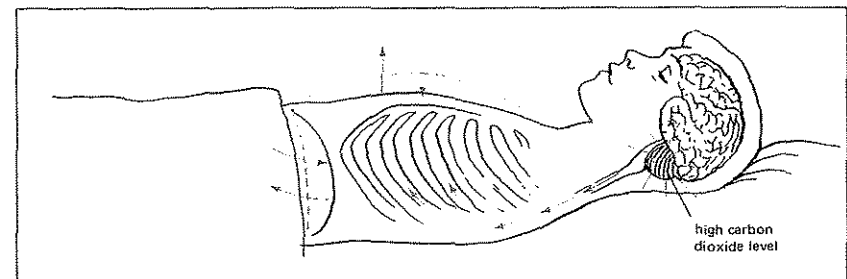


Figure F

Why do you breathe?

Breathing is *automatic*. When the level of carbon dioxide in your blood increases, a message goes to your brain. Then, your brain sends a message to your diaphragm and rib muscles to move. You have taken a breath without thinking!

SPELL THE MISSING WORD Fill in the missing letters to spell the terms that fit the definitions.
When you have answered correctly, you will spell another term in the box.

1.	_____	x	_____	a		e
2.				m		s _____ l _____
3.				i		h _____ l _____
4.	d	_____	a	_____	h	_____ a _____ m
5.				r	_____	b _____

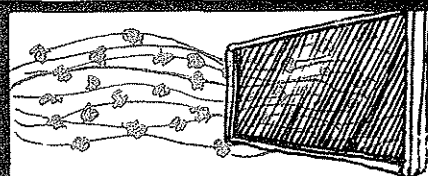
1. to breathe out
2. the diaphragm is one
3. to breathe in
4. a large, flat muscle
5. bones in your chest cavity

REACHING OUT Don't try this, but you can't kill yourself by holding your breath.
Can you figure out why?

INHALING OR EXHALING? Each of the following goes either with *inhaling* or *exhaling*.
Place a check (✓) in the box where you think it belongs.

		Inhaling	Exhaling
1.	air moves out of the lungs		
2.	air moves into the lungs		
3.	lungs become smaller		
4.	lungs become larger		
5.	chest becomes smaller		

HOW DOES THE RESPIRATORY TRACT FIGHT GERMS AND POLLUTION?



17

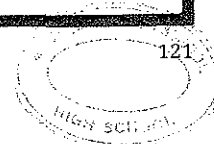




pollen: a powder-like material given off by some plants

mucus: a sticky substance made by the body

cilia: microscopic hairs



AIM | How does the respiratory tract 17 | fight germs and pollution?

A fort has strong protection. Soldiers in the fort fight off enemies that try to enter.

Parts of the respiratory tract are like soldiers. They fight to protect us from germs, dust, and pollen that are in the air.

Where are these body "soldiers"? How do they work?

The first "line-of-defense" is found in the nose.

The inside of the nose is lined with small hairs and a sticky liquid called mucus.

- The hairs filter out dust and pollen.
- The mucus traps germs (usually bacteria) as well as dust and pollen.

The nose cannot keep out all harmful substances. Some get past the nose and enter the windpipe. Sometimes harmful substances enter the windpipe from the mouth as well. So the windpipe must continue the fight.

The windpipe, like the nose, is lined with mucus. It is lined also with very tiny (microscopic) hairs called *cilia* [SIL ee uh]. Cilia are always beating in an outward direction, like a broom that keeps sweeping towards a door leading outside. A single hair is called a *cilium* [SIL ee um].

- The mucus traps many harmful substances.
- The cilia sweep them outward.

Coughing and sneezing also help. Coughing and sneezing build strong gusts of air. This forces out many harmful things from the respiratory tract.

Sometimes our body soldiers fail in their jobs and we become ill. Then we must take proper care of ourselves in order to be healthy again.

KEEP THEM OUT!

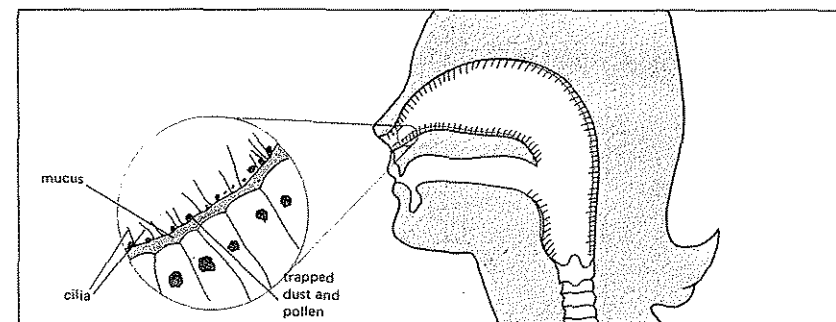


Figure A

1. Hairs and mucus in the nose filter out tiny solids like _____ and _____.
2. Mucus also traps _____.
3. Trapped dust and pollen "tickle" our noses. This makes us _____.
4. a) How do sneezing and coughing help fight disease? _____
- b) Why should you always "cover" a sneeze or cough? _____

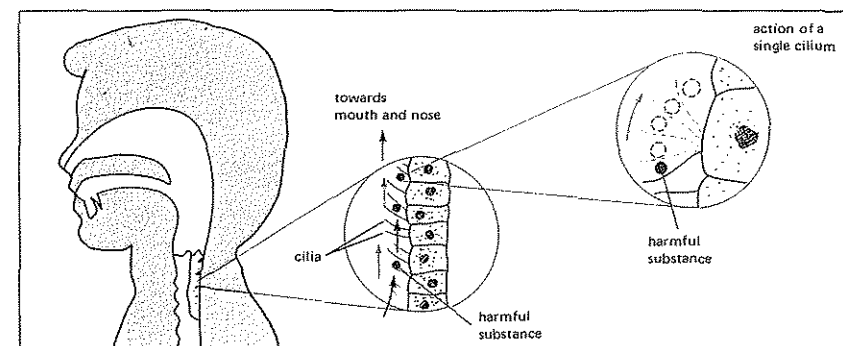
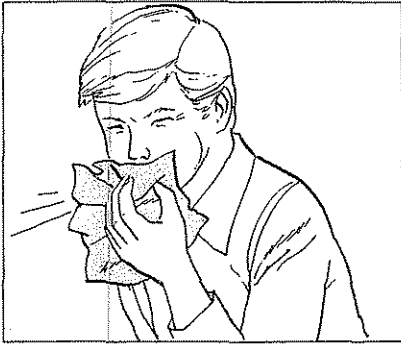


Figure B

5. a) Harmful substances that reach the windpipe are trapped by _____.
- b) They are swept outward by microscopic hairs called _____.
6. Windpipe cilia are always moving _____ towards the lungs, towards the mouth and nose.



What do you think?

Why shouldn't we try to stop a
sneeze? _____

Figure C

A heavy sneeze builds a wind of about 394
kilometers (245 miles) per hour.

COMPLETING SENTENCES Complete the sentences with the choices below. One of these
may be used twice. One of these choices may be used three times.

sneeze
dust, pollen, and germs
respiratory tract

mucus
outward
cough

hairs
dust and pollen
moving

1. The nose has small _____.
2. Hairs in the nose trap _____.
3. The nose makes a sticky liquid called _____.
4. Mucus traps _____.
5. The windpipe is lined with sticky _____ and microscopic
_____.
6. Tiny microscopic _____ are called cilia.
7. Microscopic hairs of the windpipe are always _____.
8. The cilia of the windpipe move harmful substances _____.
9. You build a heavy gust of air when you _____ or _____.
10. Coughing and sneezing help push harmful substances from the _____.

MATCHING Match the two lists. Write the correct letter on the line next to
each number.

- | | |
|----------------------------------|-------------------------|
| 1. _____ respiratory tract | a) sticky liquid |
| 2. _____ mucus | b) build great force |
| 3. _____ dust, pollen, and germs | c) can be harmful |
| 4. _____ nose hairs | d) breathing path |
| 5. _____ coughing and sneezing | e) trap dust and pollen |

WORD SEARCH The words in this list are hidden within the groups of letters.
Try to find each word. When you find it, draw a line around the
word. The spelling may go in any direction.

LUNGS
MOUTH
NOSE
TRACHEA
AIR SACS
MUCUS
HAIR
COUGH
SNEEZE
GERMS
BACTERIA

S	E	Z	E	E	N	S	H	S	E
R	I	S	C	A	S	R	I	A	E
H	L	E	S	L	I	E	I	A	Z
G	D	O	N	A	C	R	T	E	C
U	A	S	C	G	E	R	M	S	H
O	M	O	U	T	H	Z	T	O	Y
C	M	U	C	U	S	T	S	N	L
G	H	A	I	R	M	I	L	Z	L
Z	B	T	R	A	C	H	E	A	I
L	U	N	G	S	G	A	R	Y	M

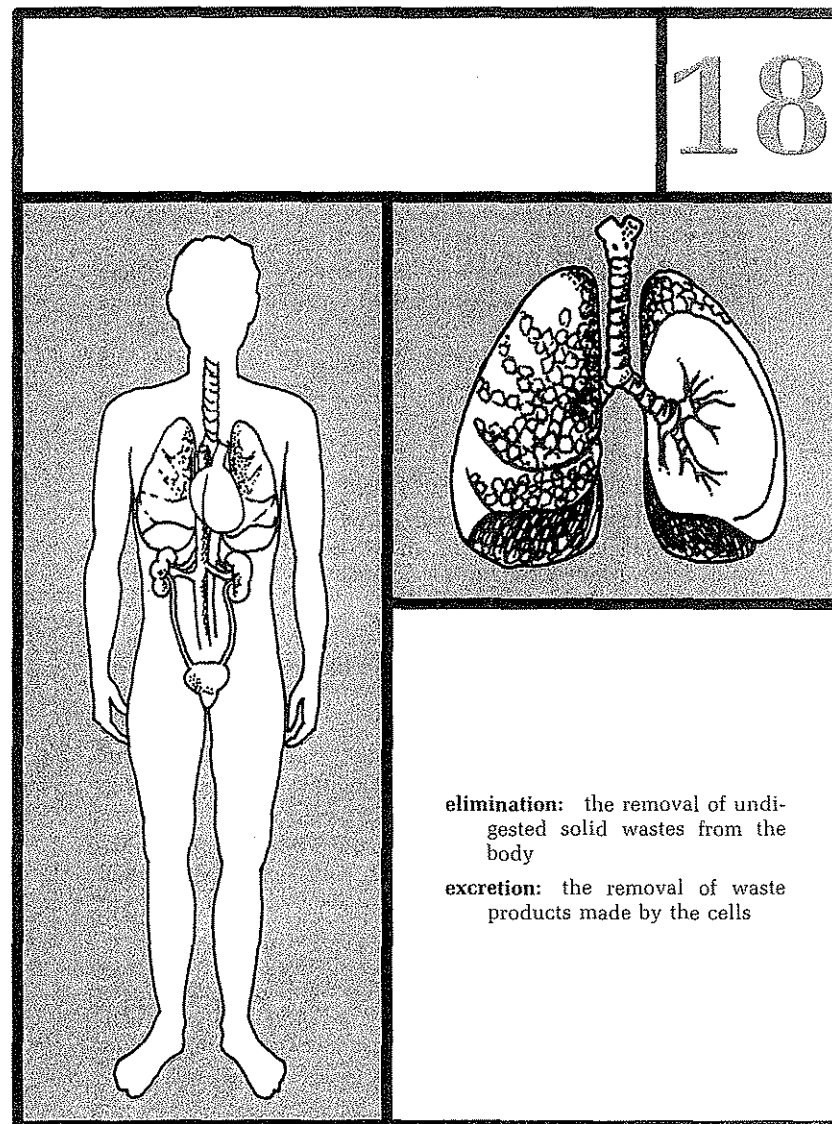
REACHING OUT

We can breathe in through the mouth or the nose. Air takes longer to reach the lungs when we breathe through the nose.

More germs may be trapped during this longer trip. What other advantage does breathing through the nose have?

WHAT IS THE EXCRETORY SYSTEM?

18



AIM | What is the excretory system?

18

Can you imagine a city without sewers, chimneys, or garbage removal? Waste materials would pile up and up. Before long, everyone would have to move. Nobody could live there.

Your body must get rid of wastes too. You cannot live without getting rid of waste products.

The body makes several kinds of waste materials. There are two main groups: *undigested solid wastes* and *wastes made by the cells*.

You have learned that undigested solid wastes leave the body through the *large intestine*. This process is called *elimination*.

The cells make many different wastes. These wastes include water, heat, carbon dioxide, salts, and urea.

The removal of waste products made by the cells is called *excretion*. In excretion, blood picks up the wastes from the cells. The wastes are sent to special organs that pass them out of the body.

The main organs of excretion are the *lungs*, *kidneys*, and *skin*. Together, these organs make up the excretory [EKS cruh tor ee] system.

LUNGS

You have learned that the lungs excrete *carbon dioxide* waste. The lungs also excrete small amounts of heat and water.

SKIN

The skin excretes most of the body's waste heat. In addition, the skin removes some water, salts, and a very small amount of urea. These wastes are excreted by the skin as sweat or perspiration [PUR spir AY shun].

KIDNEYS

The kidneys excrete a liquid waste called *urine*. Urine is a mixture. It is made mostly of *water* and *urea*. But it also contains some *salts*. Some heat is also removed from the body by the kidneys.

FIND THE PARTS

Figure A shows the organs that get rid of waste.

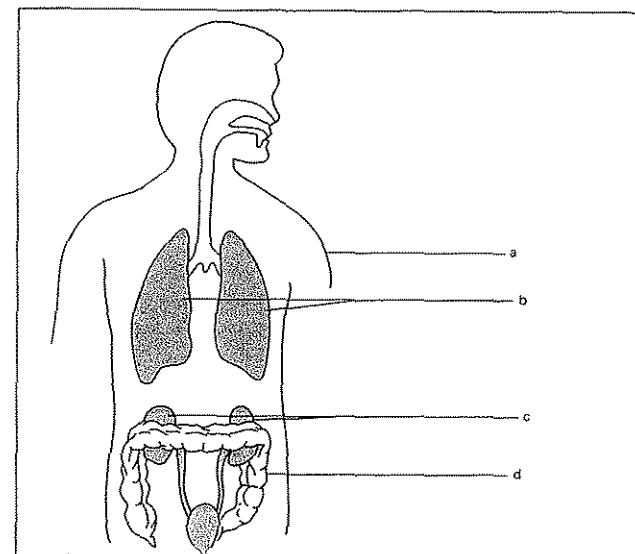


Figure A

- Can you identify them? Place the correct letter next to the name of each organ.
 kidneys _____ large intestine _____
 lungs _____ skin _____
- Which of these is an organ of elimination? _____
- Which are organs of excretion? _____
- List five waste products the body must excrete. _____
- a) Which one of these waste materials is excreted *only* by the lungs?

 b) Which other waste materials do the lungs help excrete? _____

6. The kidneys excrete a liquid mixture called urine.

a) Name the two main waste products of urine. _____ and _____

b) What other waste products are found in urine? _____ and _____

7. a) What is the main waste excreted by the skin? _____

b) What other waste products does the skin excrete? _____, _____, and _____

THE KIDNEY SYSTEM

Figure B shows the kidney system.

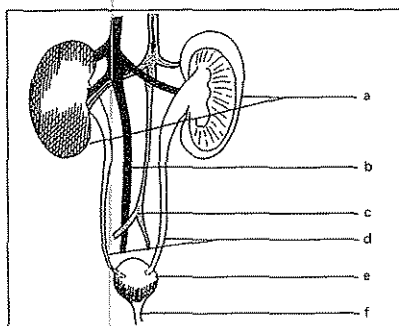


Figure B

1. The liquid waste excreted by the kidneys is called _____
urine, perspiration

2. How many kidneys does a person have? _____

Each part of the kidney system is described below. Try to identify each part from its description. Write the letter of each part on the line next to the description.

3. _____ Kidneys—shaped like kidney beans. The kidneys make urine.
4. _____ Ureters—urine leaves the kidneys through these tubes. There are two ureters—one for each kidney.
5. _____ Bladder—a sac that collects and stores urine.
6. _____ Urethra—a tube that carries urine from the bladder to the outside of the body. There is one urethra.
7. _____ Blood vessels—carry blood to and from the kidneys.
(Hint: You will have two letters for this question.)
8. Wastes from the cells are carried to the kidneys by the _____.

FIND YOUR KIDNEYS

Figure C shows where the kidneys are located.

Use your fists the same way to show where your kidneys are.

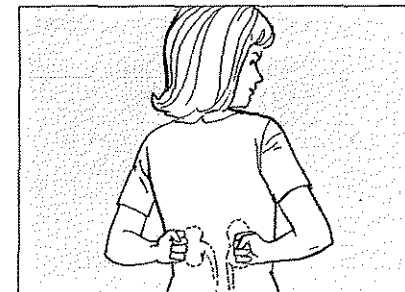


Figure C

THE SKIN

Figure D shows the inside of the skin.

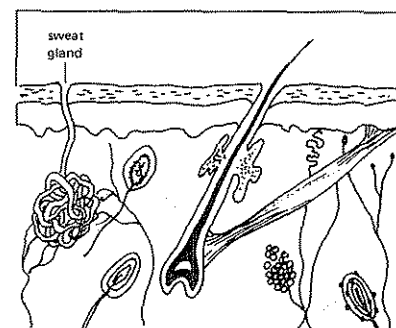


Figure D

1. The skin has many glands. One of these glands is shown in Figure D.

a) What is this gland called?

b) Name the liquid mixture made by this gland. _____

c) List four materials that make up this mixture. _____, _____, _____, and _____

d) The two main wastes excreted by the skin are _____ and _____

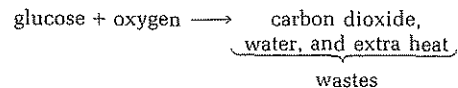
e) What carries these wastes to the skin? _____

HOW CELLS MAKE WASTE

Most cell wastes are made from:

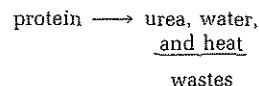
1. the "burning" of glucose for energy, and
2. the break-up of proteins.

I. Glucose burning



1. What do we call this release of useful energy by the cells? _____
(Turn back to Aim 17 if you need help.)

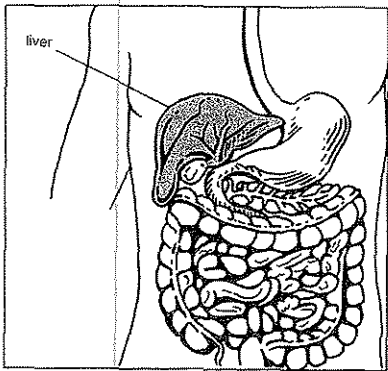
II. The break-up of proteins



Circle the letter of the correct answer.

2. Proteins are digested in the:
a) stomach only b) stomach and small intestine c) cells
3. Actual use of proteins takes place in the:
a) stomach b) small intestine c) cells

THE LIVER AS AN ORGAN OF EXCRETION



The lungs, skin, and kidneys are the main organs of excretion. They pick up waste materials from the blood, and excrete these wastes directly.

The liver is an organ of excretion too. But the liver itself does not excrete wastes. Other organs do. That is why the liver is a *secondary* organ of excretion.

Figure E
132

The liver handles cell wastes in several ways:

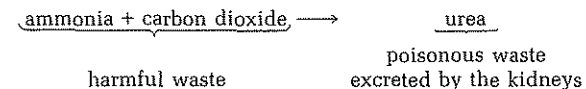
■ The liver **WEAKENS** certain harmful substances. The substances become *harmless*.

■ The liver **CHANGES** some harmful substances. They become useful substances.

For example: The liver makes *bile* from harmful substances. Bile is important in *fat digestion*. After the bile works on fat, it is *eliminated* from the bowels.

■ The liver **COMBINES** certain harmful substances. It makes them *ready for excretion*.

For example: The liver combines two harmful wastes—ammonia and some carbon dioxide. Together, these substances form *urea*. The blood carries the urea to the kidneys. It becomes part of urine. Then, it is excreted.



■ The liver also **BREAKS DOWN** dead red blood cells. They pass into the digestive tract. Then, they are eliminated with the solid waste by the bowels.

YOUR OWN WORDS Answer the following questions in brief sentences. Use your own words.

- I. 1. Why is the liver called a *secondary* organ of excretion? _____

2. Describe the four ways the liver handles cell wastes.

a) _____

b) _____

c) _____

d) _____

- II. 3. a) Bile is made from _____ substances.
harmless, harmful

b) What job does bile do? _____

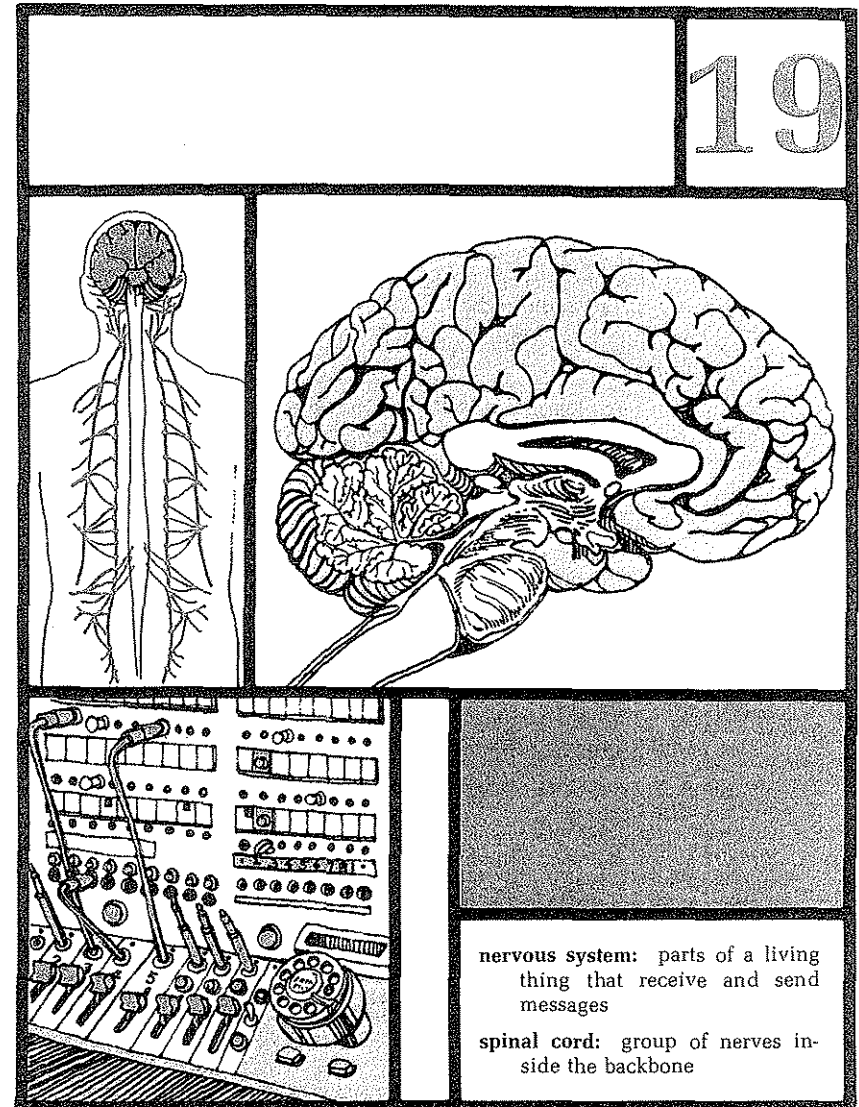
- c) What happens to bile after it does its work? _____
- d) Which organ makes bile? _____
- III. 4. a) Ammonia and carbon dioxide are _____ substances.
harmful, helpful
- b) Ammonia and carbon dioxide combine to form _____.
- c) Which organ makes urea? _____
- d) Urea is a _____ substance.
helpful, harmful
- e) Which organ excretes urea? _____
- IV. 5. a) Which organ breaks down red blood cells? _____
- b) How are dead red blood cells eliminated from the body?

6. The liver excretes wastes _____
by itself, through other organs

REACHING OUT Your body makes more waste products when you are very active. What does your heart do to help eliminate the extra wastes?

WHAT IS THE NERVOUS SYSTEM?

19



AIM | What is the nervous system?

19

Every school has an office. It is a very important place. Messages come into the office. Messages go out. Most plans for the whole school are made in the office.

In your body, the job of receiving and sending messages is done by the nervous system. The nervous system is made up of the brain, the spinal cord, and branching nerves.

The brain and spinal cord alone make up the *central nervous system*.

You have learned that the sense organs receive stimuli. But what happens to the stimuli after they are received? For example, how do you know that ice is cold, and a flame is hot? How do you decide to answer the telephone, or raise your hand in class?

Scientists explain it this way:

- Stimuli from the sense organs change to *electrical signals*.
- These electrical signals do not stay in the sense organs. Nerves carry the signals to the brain and spinal cord.
- The brain decides what each stimulus is. The brain also decides how to respond to each stimulus.
- Nerves carry "what to do" messages away from the brain. The messages go to the part of the body that will answer or respond to the stimuli.

Most "what to do" messages go to muscles. Some, however, go to glands. Most responses are carried out by muscles.

Note: In some cases, the *spinal cord*, NOT THE BRAIN, receives and sends messages of how to respond to a stimulus. You will learn more about this later.

NERVE CELLS

The nerves of the nervous system are made up of nerve cells. Each nerve cell is called a *neuron* [NOO rahn].

Neurons are well suited to performing their job of carrying messages. A group of neurons looks like a string of space-age telephones.

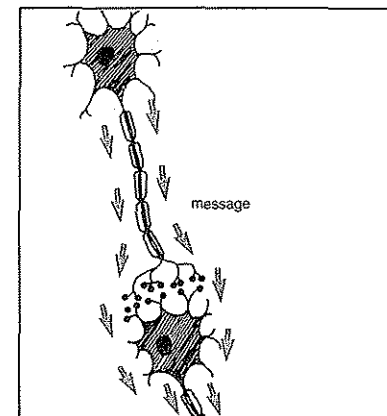


Figure A

Look at Figure A. It shows a message moving along several neurons.

Neurons form a pathway along which electrical signals travel. At one end of the pathway is a sense organ. At the other end is the muscle or gland that responds to the sense organ.

THE SPINAL CORD

The spinal cord is made up of many nerves. These nerves are inside the spinal column (backbone). The backbone protects the nerves.

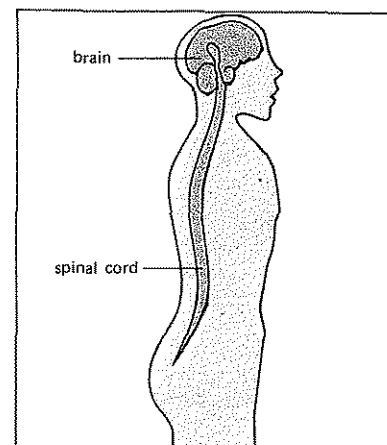


Figure B

Your spinal cord runs down the center of your back. It extends from the base of the brain to the tailbone.

Some emergency responses must happen extra fast. There is no time for the brain to decide how to respond. Delay can cause severe injury—or even death.

In these cases, the *spinal cord*—not the brain, sets up the response. The response takes place even before the message reaches the brain.

These emergency responses to stimuli are called *reflexes*. You will learn more about reflexes in Aim 23.

FIND THE PARTS

Find the parts of the nervous system. Write their names on the correct lines. Choose from the parts listed below.

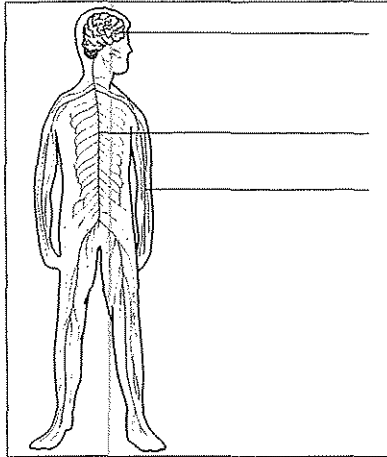


Figure C

spinal cord
nerves
brain

Name the parts that make up the central nervous system.

FILL IN THE BLANKS

Write the correct term in each blank to answer the question or complete the sentence.



Figure D

1. Name the sense organs.

2. Four of the sense organs send nerves right into the brain. Which organs are they? (Think of your own body.)

3. Most nerves of one of the sense organs go to the spinal cord before they go to the brain. Which organ is this? (Think of your own body.)

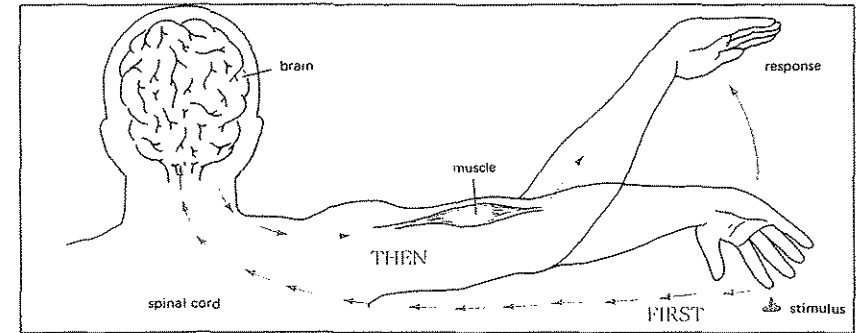


Figure E

NERVES CARRY MESSAGES IN ONE DIRECTION ONLY.

- Some nerves carry messages to the brain and spinal cord.
 - Other nerves carry messages away from the brain and spinal cord.
1. Nerves that carry stimuli lead _____ from the brain and spinal cord.
to, away
 2. Nerves that carry messages for responses lead _____ from the spinal cord.
to, away
 3. Most messages of response lead to _____.
 4. Most responses are carried out by _____.
 5. In what energy form are nervous system signals? _____

THE BRAIN

The brain is made up of three main sections. They are the cerebrum [ser EE brum], the cerebellum [ser uh BEL um], and the medulla [muh DUL uh].

Different parts of the brain control different activities.

■ The cerebrum is the largest part of the brain. It controls the senses, thought, memory, and learning. It also controls certain voluntary muscles. You use voluntary muscles for activities like walking, talking, and writing.

■ The cerebellum works with the cerebrum to control voluntary muscles. The cerebellum also helps you keep your balance.

■ The medulla controls many vital involuntary functions. For example, the medulla controls breathing and heartbeat. It also controls sneezing and blinking.

Look at the illustration below. It shows the parts of the brain that control certain activities.

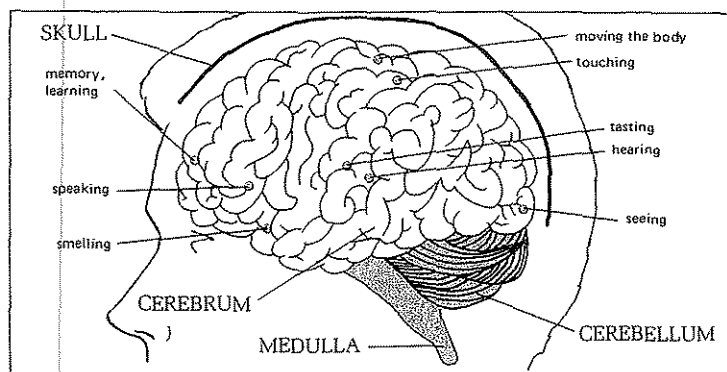


Figure F

Answer each of the following questions.

(Hint: All of the questions have to do with the cerebrum.)

1. What might happen if you are hit very hard on the back of your head? _____
2. What might happen if you are hit very hard on the front of your head? _____
3. What might happen if you are hit hard on the side of your head — towards the middle? _____
4. The brain is one of the most protected parts of your body.
 - a) What protects your brain? _____
 - b) Why does it protect so well? _____
 - c) Of what is it made? _____
5. Often, when you are thinking deeply, you close your eyes. How does closing your eyes help you to concentrate? _____

COMPLETING SENTENCES

Complete the sentences with the choices below. Two of these may be used twice.

nerves	sends	muscles
one direction	spinal cord	to
receives	away from	brain
bones	stimuli	response

1. The nervous system _____ and _____ messages.
2. The parts of the nervous system are: the _____, _____, and _____.
3. Nerves carry messages in only _____.
4. Some nerves carry messages _____ the brain and spinal cord. Some nerves carry messages _____ the brain and spinal cord.
5. _____ are carried to the brain and spinal cord by nerves.
6. Messages of _____ are carried away from the brain and spinal cord.
7. The _____ "decides" what to do about most stimuli.
8. Most messages of response are sent to _____.
9. Most responses are carried out by _____.
10. The brain and spinal cord are protected by _____. (Think of your own body.)

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--------------------------------------|-----------------------------------|
| 1. _____ parts of the nervous system | a) an action |
| 2. _____ stimulus | b) brain, spinal cord, and nerves |
| 3. _____ response | c) a signal to do something |
| 4. _____ brain and spinal cord | d) carry messages |
| 5. _____ nerves | e) central nervous system |

COMPLETE THE CHART

Twelve actions are listed below. Each action is controlled by a different part of the brain. Two actions are controlled by two parts. Place a check [✓] in the proper box (or boxes) for each action.

	ACTION	CONTROLLED BY		
		cerebrum	cerebellum	medulla
1.	hearing			
2.	seeing			
3.	moving the body			
4.	heartbeat			
5.	tasting			
6.	balance			
7.	sneezing			
8.	learning			
9.	breathing			
10.	speaking			
11.	memory			
12.	blinking			

REACHING OUT

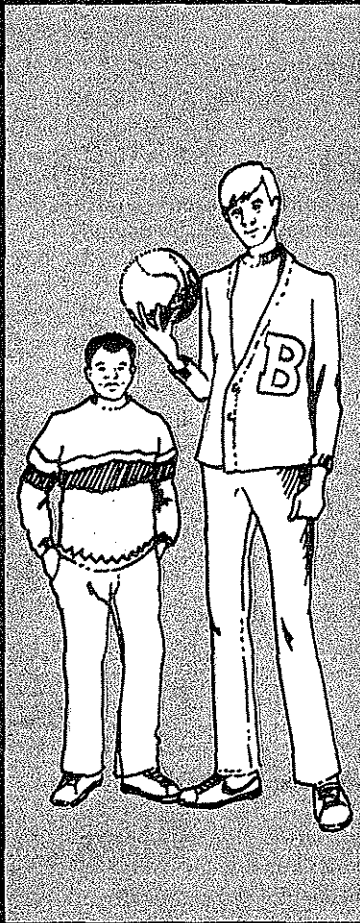
Responses that are planned are *voluntary* responses. Responses that are not planned are *involuntary* responses.

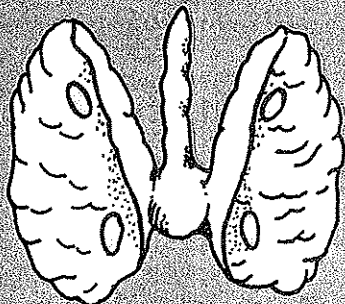
1. What was the last voluntary response you did?

2. Can you name an involuntary response that you are probably doing right now?

WHAT IS THE ENDOCRINE SYSTEM?

20





hormones: special chemicals made by the endocrine glands

ducts: tubes

AIM | What is the endocrine system?

20

Conditions inside and outside your body are always changing. Some of these changes can be harmful.

Your body has two organ systems to help it adjust to these changes. They are the nervous system and the endocrine [EN doh krin] system.

You learned about the nervous system in the last aim. It uses electrical signals to respond to changes.

The endocrine system is made up of many glands. These glands make chemical messengers called hormones. The endocrine glands are shown on the next page.

You know about some glands, like the salivary glands and the pancreas. But these glands are not endocrine glands. What, then are the differences between endocrine glands and non-endocrine glands?

NON-ENDOCRINE GLANDS

The chemicals (enzymes) made by non-endocrine glands flow through tubes called ducts. These chemicals empty directly into the place they will be used.

For example, the salivary glands and the pancreas secrete digestive enzymes. These enzymes flow through ducts. The ducts empty directly where the enzymes are used.

For example:

- saliva empties directly into the mouth;
- enzymes from the pancreas empty directly into the small intestine.

ENDOCRINE GLANDS

Endocrine glands are different. Endocrine hormones

- do not move through ducts, and
- they do not empty directly where they will be used.

Hormones from the endocrine glands empty into the bloodstream. The blood carries the hormones to the place where they do their work.

Hormones help the body adjust to changes. But that is not all they do. Hormones also

- a) help control chemical reactions in the body,
- b) affect maturity and reproduction, and
- c) help regulate physical and mental development.

THE ENDOCRINE GLANDS—THEIR LOCATIONS

Figure A shows the endocrine glands. Each gland is described below. Identify each gland from its description. Then write the name of the gland on the proper line of the diagram.

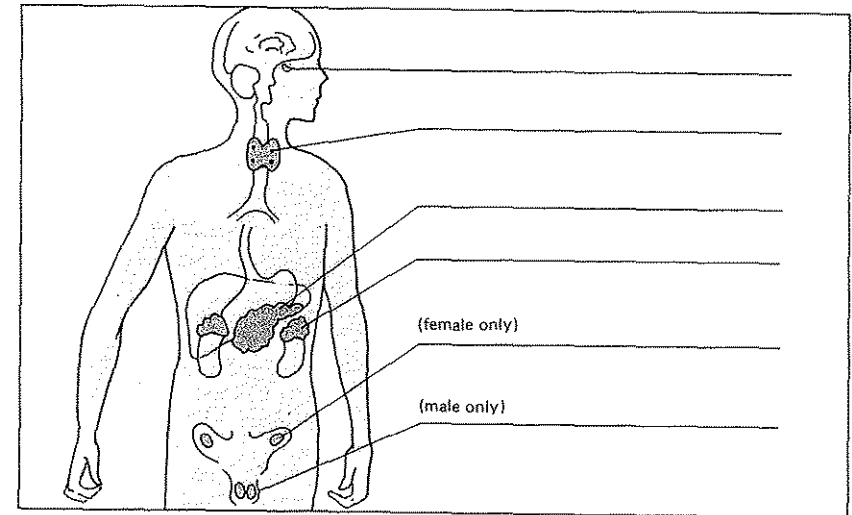


Figure A

PITUITARY [pih TOO ih TAIR ee] **GLAND** – small round gland at the base of the brain.

THYROID [THY royd] **GLAND** – butterfly-shaped gland at the base of the neck.

PARATHYROID GLANDS – four small glands embedded in the back of the thyroid gland.

THYMUS – located in the upper chest.

ADRENAL [ad REE null] **GLANDS** – two separate glands. One adrenal gland is located on the top of each kidney.

ISLETS OF LANGERHANS – glands are scattered throughout the pancreas.

GONADS – (sex glands) These glands are different in males and females.

In males, the gonads are called **TESTES**. There are two testes. They are located in the lower groin.

In females, the gonads are called **OVARIES**. There are two ovaries. The ovaries are almond-shaped. They are located in the lower abdomen area.

THE ENDOCRINE GLANDS—THEIR FUNCTIONS

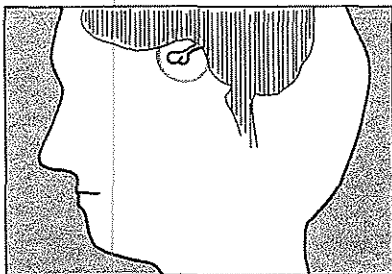


Figure B

PITUITARY GLAND. This gland makes many hormones. Some regulate growth and the production of sex cells.

The pituitary gland also controls other glands. For this reason, it is called the "master gland."

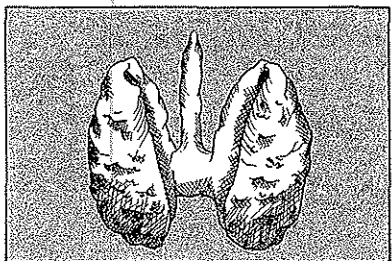


Figure C

THYROID GLAND. This gland regulates metabolism. Metabolism is all of the chemical reactions that take place in an organism.

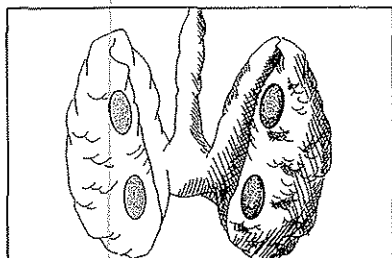


Figure D

PARATHYROID GLANDS. Regulate the use of calcium and phosphorus.

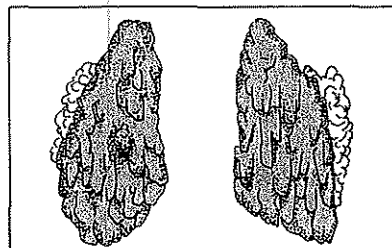


Figure E

THYMUS. Produces antibodies that help the body fight infection.

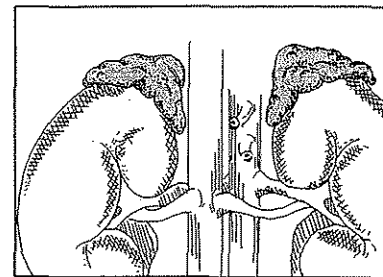


Figure F

ADRENAL GLANDS. Help the body deal with stress—especially sudden stress.

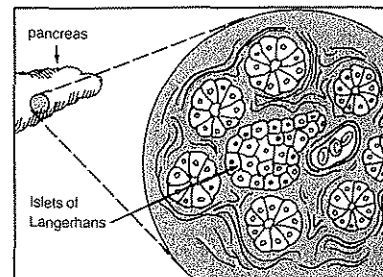


Figure G

ISLETS OF LANGERHANS. Produce the hormone insulin. Insulin helps control the amount of sugar in the blood.

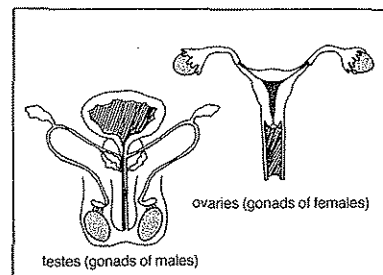


Figure H

GONADS. The gonads are the sex glands. The sex glands are different in males and females. Sex glands produce the cells needed for reproduction.

The sex glands of males are the testes. The testes make male reproductive cells called sperm. The testes also produce male sex hormones.

- Male sex hormones change boys into men. They help boys develop adult male characteristics—like a deeper voice and facial hair.

The sex glands of females are the ovaries. The ovaries make female reproductive cells called eggs. They also make female sex hormones.

- Female sex hormones change girls into women. They help girls develop adult female characteristics—like a woman's shape.

ABOUT HORMONES

Each endocrine gland makes one or more hormones. There are many kinds of hormones.

Each hormone is "recognized" by only certain cells. This hormone regulates only these cells. All other cells are not affected.

The cells that a given hormone regulates are called the target cells of that hormone.

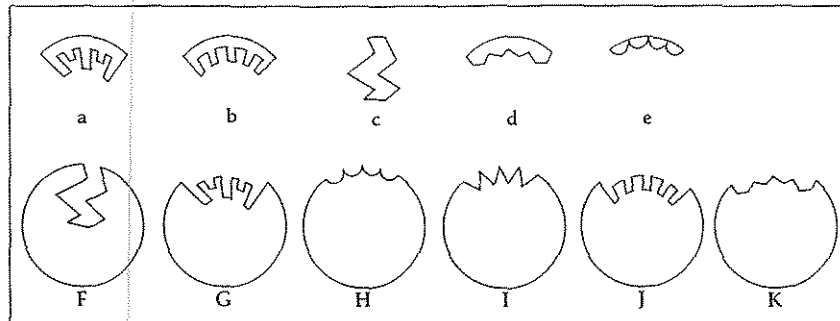


Figure I

Look at Figure I. The small shapes stand for hormones. Each shape stands for a different hormone. These are labeled with small letters.

The large shapes stand for different kinds of cells. These shapes are labeled with capital letters. Study the shapes. Then answer the questions.

- I. Find the target cell for each of the hormones listed below. Write the letter of the target cell in the space next to each number.

1. _____ hormone a 3. _____ hormone c 5. _____ hormone e
2. _____ hormone b 4. _____ hormone d

- II. We can say this another way.

1. Cell F will be acted upon only by hormone _____
2. Cell G will be acted upon only by hormone _____
3. Cell H will be acted upon only by hormone _____
4. Cell J will be acted upon only by hormone _____
5. Cell K will be acted upon only by hormone _____

ENDOCRINE-RELATED DISEASES



The Islets of Langerhans produce a hormone called *insulin*. Insulin regulates the amount of sugar in the blood.

If not enough insulin is produced, a disease called *diabetes* [DY uh bee teez] develops. Diabetes is a common and serious disease. Do you know anyone who has it?

There is no cure for diabetes. But it can be treated. Most people with diabetes must take daily injections of the insulin hormone.



One hormone secreted by the pituitary gland regulates body growth. The amount of this hormone produced when a person is a child is very important.

If too little of this hormone is made, *dwarfism* can result.

If too much of the hormone is made, *giantism* can develop.

You have heard of *AIDS*. AIDS is caused by a virus that attacks the thymus gland.

The thymus gland is important. It produces *antibodies*. Antibodies are chemicals that fight diseases.

The AIDS virus damages the thymus gland. As a result, no more antibodies are produced. Germs then have a "field day." They multiply over and over. And without antibodies, the body cannot fight them off.

Many diseases develop. The symptoms grow worse each day. The victim gets weaker and weaker. Death always results.

AIDS is a growing threat to everyone. Scientists are working very hard to find a cure and a prevention for this deadly disease.

COMPLETING SENTENCES

Complete the sentences with the words below. One word will be used twice.

changing
maturity
electrical
all parts
ducts
nervous

mind
hormones
specific
reproduction
adjusting
target

endocrine
chemical
bloodstream
body
harmful

1. The body's environment is always _____.
2. Some of these changes can be _____.
3. The body is always _____ to these changes.
4. The two organ systems that help the body adjust to changes are the _____ system and the _____ system.
5. Endocrine glands make chemicals called _____.
6. Endocrine glands do not have _____. Their hormones empty into the _____.
7. Blood carries hormones to _____ of the body.
8. Each type of hormone is absorbed by _____ cells. These cells are called _____ cells.
9. Hormones help the body adjust to changes. They also help regulate _____ reactions in the body.
10. Hormones also affect _____, _____, and the development of the _____ and _____.

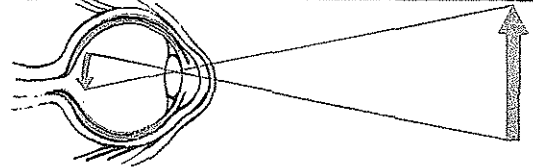
REACHING OUT

A person without a hat is said to be hatless. Some birds do not have properly developed wings. These birds are said to be wingless or flightless.

Endocrine glands are called by another name also. What is that name?

Use the above examples and what you know about endocrine glands to find the answer. (Hint: The name ends in "less.")

WHY DO WE ACT THE WAY WE DO?



21




stimulus (plural: stimuli): something that makes you act in a certain way

response: an answer to some kind of action

AIM | Why do we act the way we 21 | do?

A class bell gives you a message. It tells you that the period is over. You answer this message by getting ready to leave.

Your body gets all sorts of messages. We call these messages *stimuli* [STIM yoo lie]. One message is a *stimulus*. Your answers to these messages are called *responses*.

Some stimuli come from outside the body. Some come from inside. You respond to stimuli in many ways.

Some responses, like answering a telephone, are planned (voluntary). You think about what you are going to do. Other responses, like yawning, are not planned (involuntary). They happen by themselves.

Some responses take place and you do not know they are happening. These responses happen mostly inside the body. An example is the squeezing of bile into the small intestine when you eat fat. Can you think of other examples?

Most animals have special sense organs that receive stimuli. Humans have five kinds of sense organs. They are the eyes, ears, nose, tongue, and skin.

The sense organs are sensitive to special kinds of stimuli. For example, your eyes are sensitive to light. They are not sensitive to sound, smell, or taste. Your tongue is sensitive to taste. You cannot hear, smell, or see with your tongue.

Our senses tell us what is going on around us. Responses to messages from our senses help protect us and keep us alive.

FIND THE PARTS

Figure A shows the sense organs. Place the letter of the correct organ on the blank next to each term.

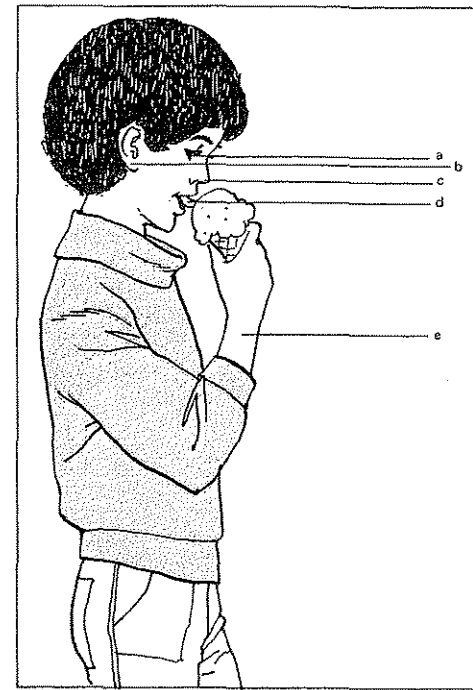


Figure A

1. skin _____
2. nose _____
3. eyes _____
4. tongue _____
5. ears _____

MATCH THE ORGANS

Match the organs with the stimuli. Choose from the stimuli listed on the right.

- | | |
|--------------------------------------|-------|
| 1. The eyes are sensitive to _____. | taste |
| 2. The ears are sensitive to _____. | sound |
| 3. The nose is sensitive to _____. | touch |
| 4. The tongue is sensitive to _____. | light |
| 5. The skin is sensitive to _____. | smell |

WORKING WITH STIMULI AND RESPONSES

Each figure shows a stimulus and a response. Study each diagram, then answer the questions that go with each diagram. Choose the stimuli and responses from the choices below.

STIMULI	RESPONSES
sound	pupils open wider
bad odor	face wrinkles
sour taste	ears lift
tickle	the head pulls back suddenly
dim light	laughing



Figure B

- The stimulus is a _____.
 - The response is _____.
 - This response _____ is, is not planned.
 - The boy _____ does, does not know the response is happening.
 - The important sense organ here is the _____.



Figure C

- The stimulus is a _____.
 - The response is _____.
 - The response _____ is, is not planned.
 - The girl _____ does, does not know the response is happening.
 - The important sense organs here are the _____.

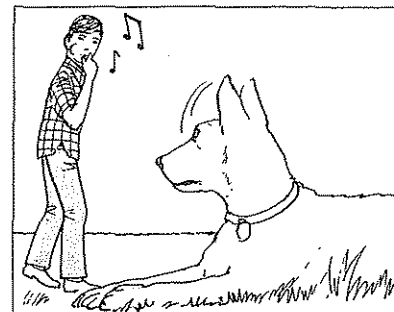


Figure D

- The stimulus is a _____.
 - The response is _____.
 - The response _____ is, is not planned.
 - The dog probably _____ does, does not know the response is happening.
 - The important sense organs here are the _____.



Figure E

- The stimulus is _____.
 - The response is _____.
 - The response _____ is, is not planned.
 - The girl _____ does, does not know the response is happening.
 - The important sense organ here is the _____.

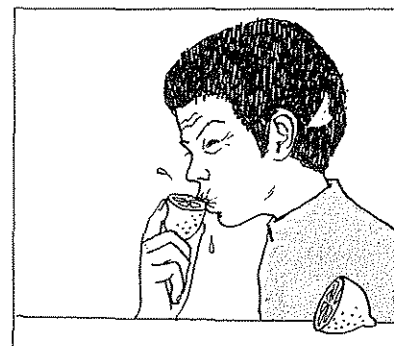


Figure F

- The stimulus is _____.
 - The response is _____.
 - The response _____ is, is not planned.
 - The boy _____ does, does not know the response is happening.
 - The important sense organ here is the _____.

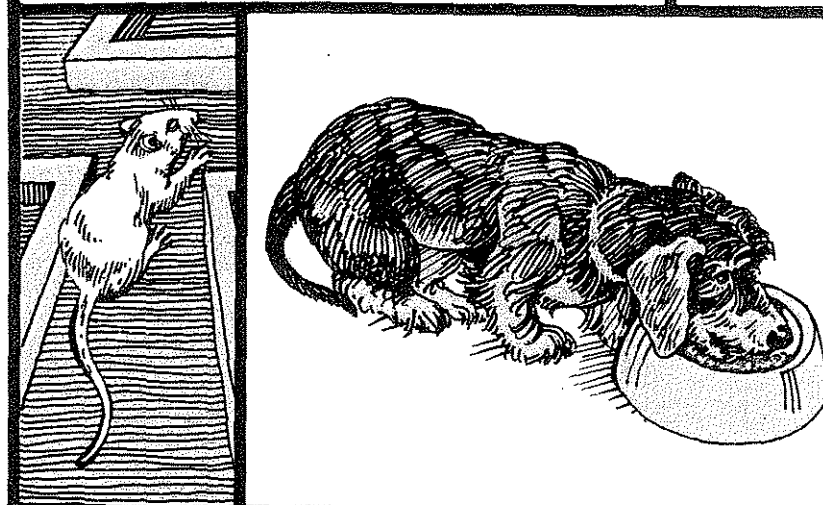
WORD Unscramble each of the following to form a word or term that
SCRAMBLE you have read in this Aim.

1. ULISTSUM _____
2. SENO _____
3. CHUOT _____
4. GOTENU _____
5. PENSEROS _____

REACHING OUT Why do we hear better when we look at the person who is talking? What does this show?

HOW CAN WE CHANGE BEHAVIOR?

22



behavior: all the actions of a living thing

conditioning: a simple kind of learned behavior

conditioned reflex: a reflex with a changed stimulus

AIM | How can we change 22 behavior?

At home or in school, behavior means being good or bad. To a scientist, *behavior* means all kinds of actions. It means how we react to all stimuli. It also means how we learn.

Scientists study behavior. They try to find out why we behave the way we do. They also try to find out how behavior can be changed.

One of the scientists who studied behavior was a Russian named Ivan Pavlov.

About 75 years ago, Pavlov experimented with dogs in a special way. He knew that dogs drool every time they see or smell food. This is a normal reflex response.

Pavlov wanted to find out if this reflex could be changed. This is what he did: Pavlov rang a bell every time he brought food to a dog. Each time the dog drooled. REMEMBER, FOOD ALWAYS MAKES A DOG DROOL.

Then Pavlov did something new. He just rang the bell. He did not give the dog any food. What do you think happened? The dog's mouth watered even though no food was there.

The dog had learned that the bell always meant food. The bell had now taken the place of the food as a stimulus that causes drooling.

A reflex where one stimulus takes the place of another stimulus is called a *conditioned reflex*.

Pavlov's dog was *conditioned* to respond to a new kind of stimulus. What was this new stimulus?

Conditioning is a very simple form of learning.

WHAT DO THE PICTURES SHOW?

TRACING PAVLOV'S EXPERIMENT

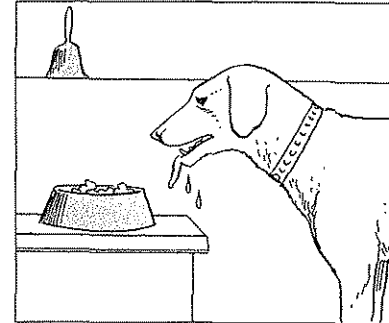


Figure A

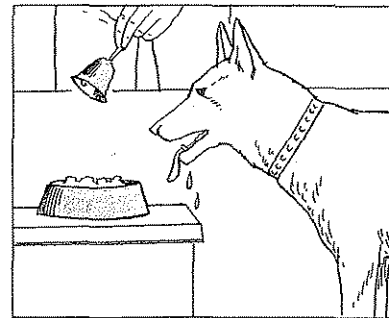


Figure B

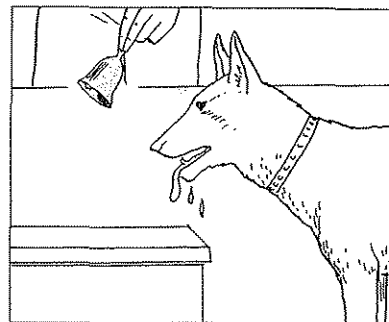


Figure C

Look at Figure A.

1. a) What *stimulus* is reaching the dog? _____
b) What is the *response* to this stimulus? _____
2. The dog _____ control this response.
can, cannot
3. The response is _____.
inborn, learned
4. This behavior is called a _____.
reflex, conditioned reflex

Look at Figure B.

5. What new stimulus has been added? _____
6. Does this stimulus usually cause drooling? _____
7. Both stimuli reach the dog _____.
at the same time, at different times

Look at Figure C.

8. Which stimulus has been taken away? _____
9. Which stimulus is reaching the dog? _____
10. The ringing bell alone now _____ make the dog drool.
does, does not
11. Without conditioning, a ringing bell _____ cause drooling.
does, does not

12. The dog drools because the sound of the bell has been connected to _____.
13. The dog has experienced a simple kind of _____.
14. This kind of behavior is called a _____
reflex, conditioned reflex

Now look back at Figure B.

15. The diagram doesn't show it, but we know that both stimuli reached the dog together _____
only a few times, many times

MORE ON CONDITIONING

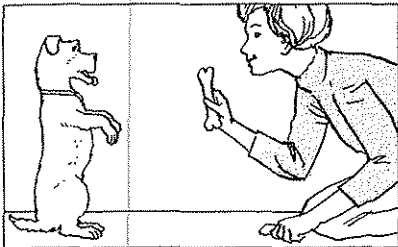


Figure D

The dog has learned to connect the sound of "sit up" with a treat.

Being given treats has conditioned him to sit up.

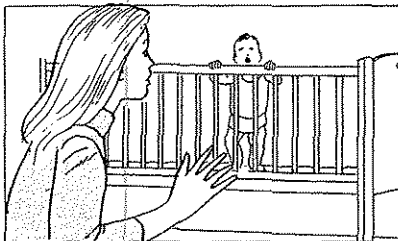


Figure E

This child has learned to get attention by crying.

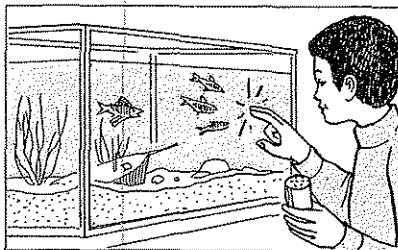


Figure F

What two stimuli have these fish learned to connect?

TRUE OR FALSE Write T on the line next to the number, if the sentence is true.
Write F if the sentence is false.

1. _____ Behavior means only being good or bad.
2. _____ Behavior means all kinds of responses.
3. _____ Scientists study how living things behave.
4. _____ Behavior is always the same.
5. _____ Pavlov studied apes.
6. _____ We can learn about people, by studying animals.
7. _____ A reflex is learned.
8. _____ A conditioned reflex is a learned response.
9. _____ A bell always causes a dog to drool.
10. _____ A bell can never cause a dog to drool.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-----------------------------|-------------------------------------|
| 1. _____ Pavlov | a) a simple form of learning |
| 2. _____ conditioning | b) all kinds of responses |
| 3. _____ reflex | c) inborn response |
| 4. _____ behavior | d) studied dog behavior |
| 5. _____ conditioned reflex | e) a reflex with a changed stimulus |

**SPELL THE
MISSING
WORD**

Fill in the missing letters to spell the terms that fit the definitions.

When you have answered correctly, you will spell another term in the box.

1.				e		a		i		r
2.			r		f		e			
3.	s		i		u					
4.		P		v		o				

1. all responses
2. inborn response
3. anything that causes response
4. man who studied conditioning

**REACHING
OUT**

How can a conditioned response be *unlearned*? Use Pavlov's "drooling" experiment as an example.

WHAT IS A REFLEX?

23



The moment you are born you do certain things by yourself. You cry, you breathe, your heart beats. You yawn, your eyes blink, your lips search for food.

You were not taught how to do these things. You were born knowing how to do them.

These kinds of responses are called *reflexes* [REE flex es].

There are many kinds of reflexes. But they are all alike in certain ways.

a) Reflexes are not learned. They are *inborn*.

b) You do not control or think about reflexes. They happen by themselves. They are *automatic* and *involuntary*.

c) A reflex is done exactly the same way every time.

In most cases, you do not know a reflex is happening. For example, jumping away from a speeding car is a reflex. You respond without thinking. You know about it only after the response has taken place.

The same is true when you touch a hot pot. You pull your hand away *before* your brain "feels" the pain.

Reflexes are very important. They protect us and help us stay alive. Reflexes control most of our body organs.

REFLEXES HELP YOU STAY ALIVE

They control important body organs.

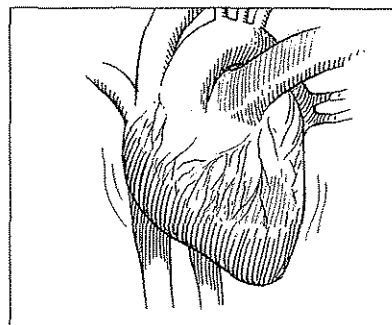


Figure A

Reflexes control your heartbeat.

1. a) What happens to your heartbeat if you are excited?

- b) What happens to your heartbeat if you are asleep?

They protect you from injury.

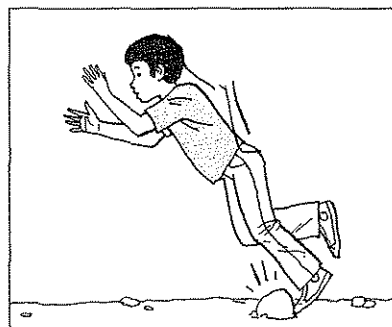


Figure C

When you trip, your hands move automatically to protect your face.

3. What part of your body do you seem to protect first automatically?



Figure B

Reflexes control your breathing.

2. Which gas stimulates this reflex?
(Hint: a waste product of oxidation.)



Figure D

When dust gets in your eyes you tear, and your eyelids flutter—automatically.

4. How does this reflex protect you?

TRACING A REFLEX

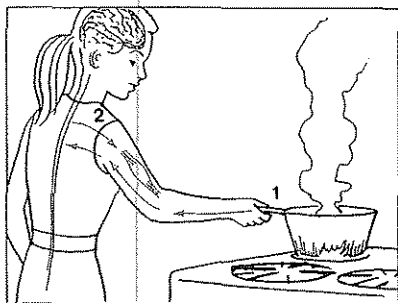


Figure O

The heat stimulus moves from the pan to the hand.

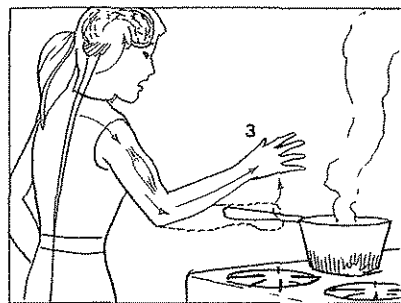


Figure P

An instant later, the message reaches the brain, which records pain in the hand.

THE STIMULUS: touching a hot object

THE RESPONSE: pulling the hand away

FIRST Nerves send the message of "heat" to the spinal cord. The spinal cord decides what to do.

SECOND Nerves carry this message of "what to do" away from the spinal cord. It goes to the muscles of the hand.

THIRD The message tells the muscles to "let go" of the hot object.

Answer the questions that go with each number in Figures O and P.

1. a) At this point, the brain _____ know what is happening.
does, does not
- b) The girl _____ feel pain.
does, does not
2. The girl _____ had a chance to say "ouch."
has, has not
3. a) The brain now _____ know what is happening.
does, does not
- b) The girl now _____ feel pain.
does, does not
- c) Was the feeling of pain needed for the response to take place?

CHOOSE ONE Choose the correct word or term for each statement. Write your choice in the space.

1. Reflexes are _____.
learned, inborn
2. You _____ control reflexes.
can, cannot
3. Reflexes _____ planned.
are, are not
4. Reflexes _____ happen by themselves.
do, do not
5. You _____ know that most reflexes are happening.
do, do not
6. Reflex responses are carried out by _____. (Careful, this one is tricky.)
nerves, muscles
7. Most reflexes are very _____.
slow, fast
8. A reflex always happens _____.
the same way, in different ways
9. Reading _____ a reflex.
is, is not
10. Blinking when something enters your eye _____ a reflex.
is, is not

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

1. ALISVA _____
2. XERFEL _____
3. NAIP _____
4. NORBNI _____
5. SECLUMS _____

ABOUT INSTINCTS

An *instinct* [in STINGKT] is like a reflex. It is *inborn* and *automatic*. And it happens the same way every time. BUT, an instinct is much more complex than a reflex.

There are many instincts. Animals depend on instincts more than humans. For example, a bird uses instinct to build its nest. A bird can build a nest even if it has never seen one built.

Nest-building is complicated. A bird must choose a nesting place. It must select nesting materials. Then it must put the nest together.

Scientists believe that an instinct is a series, or chain, of reflex responses. Each response leads to another. And, if one response in the "chain" is not done, the "instinct" will not be completed—or it will not be completed correctly.

For example, if a bird cannot put its nesting materials together correctly, the nest will not be built. Or if built, the nest will not be a good one.

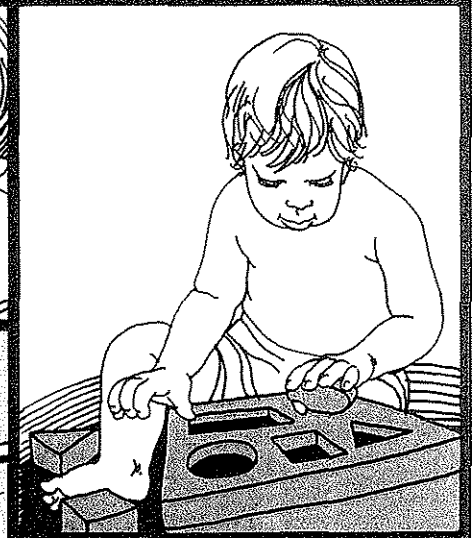
Answer these questions about instincts.

1. Instincts are _____
learned, inborn
2. Both reflexes and instincts are _____
thought out, automatic
3. Instincts are _____ complicated than reflexes.
more, less
4. An instinct is a series of inborn _____
stimuli, responses
5. For an instinct action to be completed, all steps leading to the action must be _____

REACHING OUT Some people have fast reflexes. In what kind of jobs are very fast reflexes especially important?

HOW DO YOU LEARN?

24



habit: learned behavior that is done without thinking about it

trial and error: learning by trying different ways

memory: a way of storing information

reason: ability to think things out step by step

Do you remember when you were learning to ride a bike? Chances are it wasn't too easy. How many "flops" did you take?

At first you thought about everything you had to do. You thought about the pedals. You thought about the steering.

You do not think of these things now. You just ride off. After much practice, you have *learned* to ride a bike. You do it without thinking. . . . You do it automatically.

Learned behavior that has become automatic is called a *habit*.

Many things you do every day are habits. Walking into a classroom each day and taking the same seat can become a habit. Actions that you practice a lot can become habits. Throwing a ball the same way over and over again may form a habit that improves your game.

You now know that learning can take place through *conditioning* and *habit*. But there are other ways. You can also learn through *trial and error*, *memory*, and *reason*.

■ *Trial and error* means making mistakes and learning from them. You try different ways of doing something until you find the right way.

How would you find out which key in a batch fits a padlock?

■ *Memory* keeps information stored in your brain. You can use this information anytime you need it.

What is your address? What are the names of your teachers? Your *memory* quickly gives you the answers to these questions.

■ *Reason* helps you think out a problem carefully. You think of everything that might help you find the answer.

How would you go about trying to find a lost book? The first thing you probably would say is, "Now let me see, where was I?" This is using *reason*.

ABOUT LEARNING

Each of the figures below suggests a kind of learning. On the line under each figure, write the main kind of learning you think it is.

Choose from the following: conditioning, habit, trial and error, memory, reason.

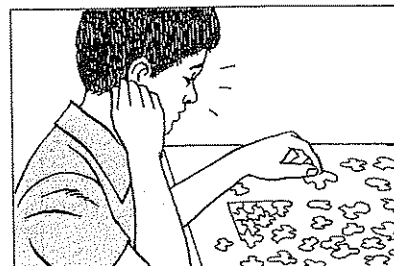


Figure A

1. _____

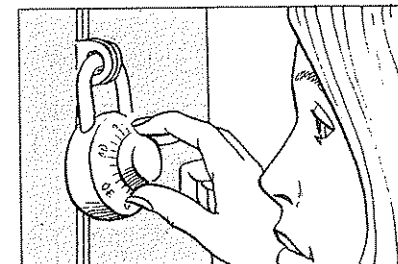


Figure B

2. _____



Figure C

3. _____

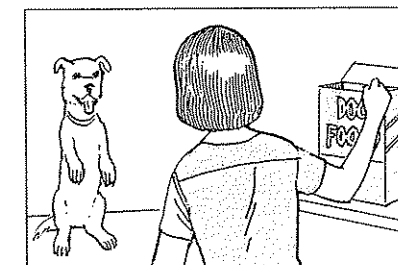


Figure D

4. _____

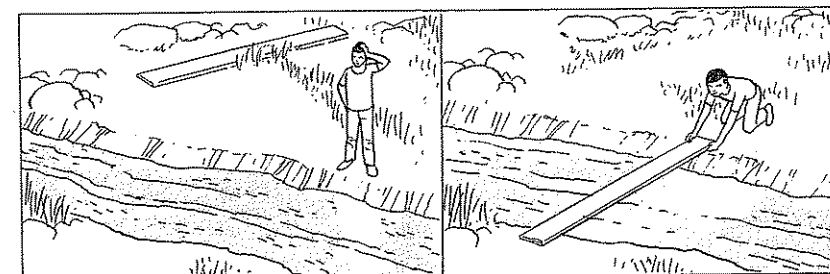


Figure E

5. _____

AIM | What is the skeletal system?

25

Have you ever seen a house being built? The first thing that goes up is the frame or *skeleton*. It supports the entire house.

Humans, and many other animals, have a skeleton too. Some animals, like crabs and insects, have a hard outer covering called an *EXO*skeleton. Humans, and other vertebrates, have an *internal*, or *ENDO*skeleton.

The human skeleton is made mostly of bone. It also has some softer tissue called *cartilage*. Your ears and the tip of your nose are made of cartilage. Squeeze them gently. Don't they feel rubbery? You can't bend bone that way.

Cartilage also lines the inner surface of most joints. A joint is the meeting place of two bones. Cartilage in the joints acts like a shock absorber. It cushions the bones.

The human skeleton has 206 bones. It supports the body. But it does even more. For example, the skeleton also:

- protects vital organs,
- allows free movement, and
- makes red and white blood cells.

PROTECTION

Think about your body. Your brain, heart, and lungs are three of your vital organs. These organs are protected by bones. Your *skull* protects your brain. Your *ribs* and *breastbone* protect your heart and lungs.

MOVEMENT

The place where bones meet is called a *joint*. Some joints are moveable. Other joints are not moveable. For example, the joints of your skull are not moveable. The joints of your arms, legs, hands, and feet, however, are moveable.

Moveable joints are held together by tough *ligaments*. Ligaments stretch easily. This allows the bones to move easily.

BLOOD CELL PRODUCTION

Some bones have tube-like canals. They are filled with soft tissue called *marrow*. Red blood cells and some white blood cells are made in the marrow.

THE HUMAN SKELETON

Figure A shows most of the 206 bones of the human skeleton. Study the diagram. Then answer the questions.

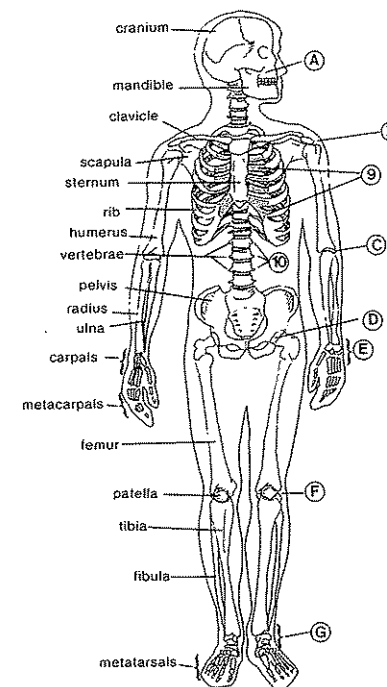


Figure A

1. a) The human skeleton is an _____ skeleton.
internal, external
- b) What do we call an internal skeleton? _____
2. The human skeleton is made mostly of hard _____ tissue.
3. a) What do we call the "rubbery" tissue that makes up some parts of the skeleton?

- b) Name two parts of the skeleton that are made of this tissue. _____
4. Look at Figure A again. Find each of the bones listed below. Then write the scientific name for each of these bones.

a) kneecap _____	f) hip bone _____
b) shin bone _____	g) collar bone _____
c) skull _____	h) shoulder blade _____
d) breastbone _____	i) backbone _____
e) jaw bone _____	j) calf bones (a pair) _____
5. Which pair of bones form a "lap"? _____
6. Which bones are most important for:

a) grasping a small ball? _____
b) throwing the ball? _____

7. Which bone is most important for talking? _____
8. What bones make up the spinal column? _____
9. Identify each of these joints. Write the letter of the joint on the line next to its description.

a) knee joint _____	e) ankle _____
b) elbow _____	f) jaw joint _____
c) wrist _____	g) hip joint _____
d) shoulder joint _____	
10. Part 9 (in color) of the skeleton is cartilage.
 - a) Which bones does this cartilage connect? _____
 - b) Why must these parts be made of cartilage? _____

11. Part 10 (in color) of the skeleton is also cartilage.
 - a) Which bones do these cartilage "discs" connect? _____
 - b) Why are these cartilage discs important? _____

12. Name the vital organs that are protected by each of the following bones.
 - a) cranium _____
 - b) ribs and sternum _____
 - c) vertebrae _____

JOINTS Bones move only at joints. There are two main kinds of joints in the human body. One is the *hinge joint*. The other is the *ball-and-socket joint*.

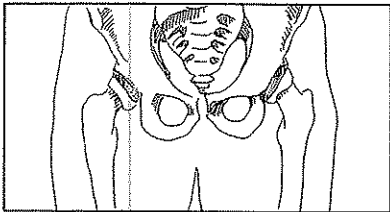


Figure B A ball-and-socket joint.

A *ball-and-socket joint* can be twisted. It permits movement in many directions. This includes rotating movements. The hip joint is an example of a ball-and-socket joint.

1. Name another ball-and-socket joint of your body. _____

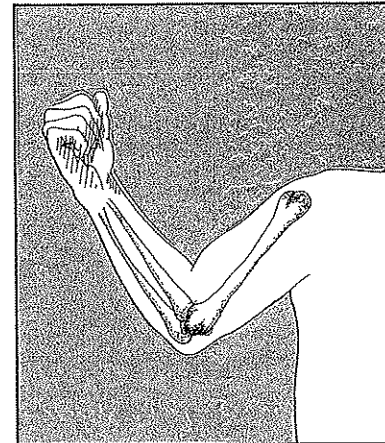


Figure C A hinge joint.

A *hinge joint* can move only in one direction—like a door hinge.

The elbow joint is an example of a hinge joint.

Bend your elbow.

2. How many directions can your elbow bend? _____
3. Name another hinge joint of your body. _____

There is still another kind of joint. It is called a *slightly moveable joint*.

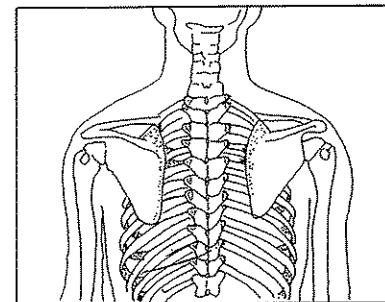


Figure D A slightly moveable joint.

The name of this joint fully describes its movement. A *slightly moveable joint* can move—but not much.

Your ribs are connected to your backbone by *slightly moveable joints*. The joints of your vertebrae (small bones that make up the backbone) are also *slightly moveable joints*.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-------------------------|----------------------------|
| 1. _____ backbone | a) hinge joint |
| 2. _____ shoulder joint | b) connects moveable bones |
| 3. _____ elbow joint | c) made up of vertebrae |
| 4. _____ cartilage | d) fills some bone canals |
| 5. _____ marrow | e) ball-and-socket joint |

COMPLETING SENTENCES

Complete the sentences with the words below.

joint
bones
ears
movement
hinge
support

skull
spinal cord
cartilage
ligaments
internal
ribs

red blood cells
ball-and-socket
breastbone
protect
nose

1. The human skeleton is an _____ skeleton.
2. The human skeleton is made up of 206 _____ and some _____.
3. The _____ and the tip of the _____ are made of cartilage.
4. Bones serve four purposes. Bones _____, _____, allow _____, and make _____.
5. The brain is protected by the bones of the _____.
6. The heart and lungs are protected by the _____ and _____.
7. The backbone encloses and protects the _____.
8. The place where two bones meet is called a _____.
9. The two main kinds of joint are the _____ joint and the _____ joint.
10. The bones at moveable joints are connected to one another by _____.

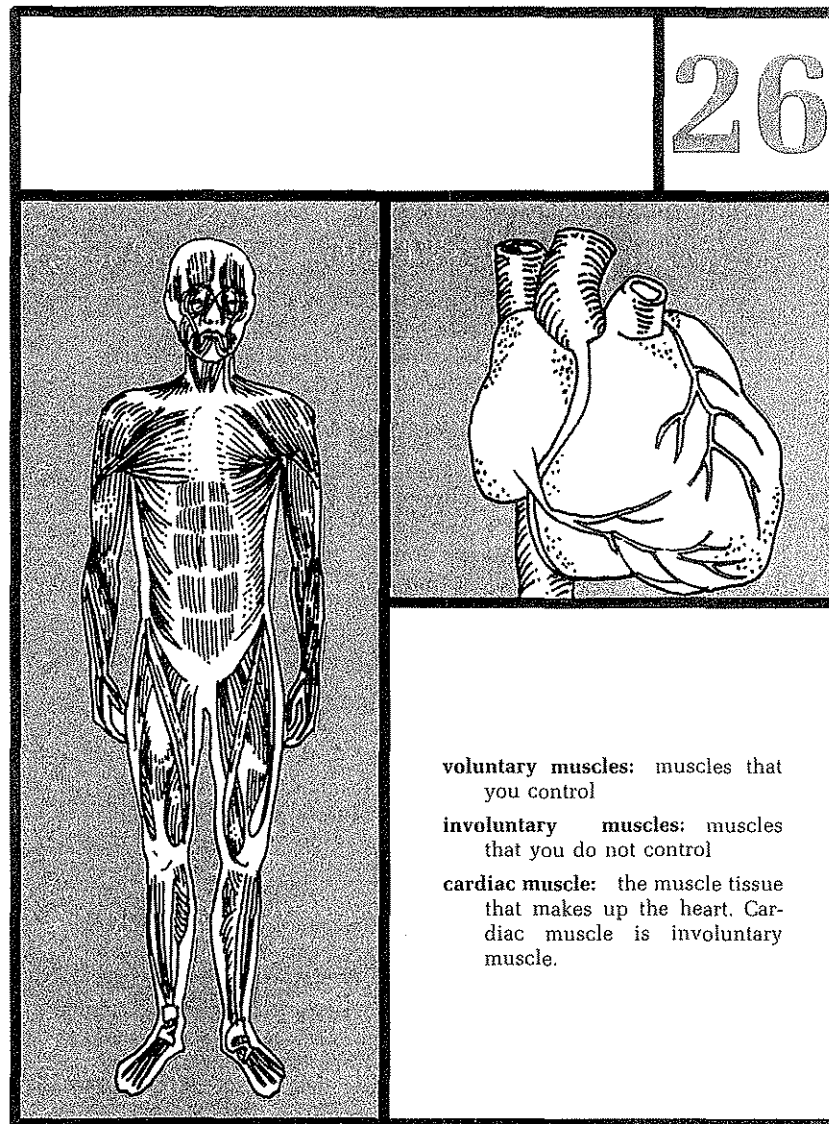
REACHING OUT—RESEARCH

Not all white blood cells are made in the bone marrow. There are two other parts of the body that make white blood cells. Use an encyclopedia, or another resource book, to find out what other parts of the body make white blood cells.

(Hint: White blood cells are also called leukocytes [LOO koh syts].)

WHAT IS THE MUSCULAR SYSTEM?

26



voluntary muscles: muscles that you control

involuntary muscles: muscles that you do not control

cardiac muscle: the muscle tissue that makes up the heart. Cardiac muscle is involuntary muscle.

What is the muscular system?

You are always moving. You walk, you talk, you write, and bite. You swallow and blink—and also wink.

Your breathe day and night. Your heart is always beating. Every moment, materials within your cells are “on the go.” Movement stops only when life stops.

Movement within cells is caused by chemical reactions. All other body movements are caused by muscles.

You have about 400 muscles. Some are large. Some are tiny. Muscles make up nearly half of your body weight.

Muscles work by *contracting*. When a muscle contracts, it becomes smaller. As a result, it **PULLS**. This pulling action produces motion.

Muscles can only pull. Muscles cannot push.

There are three main types of muscle: *voluntary* (or skeletal) muscle, *involuntary* muscle, and *cardiac* muscle.

VOLUNTARY MUSCLE

Voluntary muscles are muscles that you *control*. They move when you *want* them to move. The muscles that move your arms and legs are examples of voluntary muscles.

Voluntary muscles are attached to *bones*. For this reason, they are also called *skeletal* muscles.

Under a microscope, voluntary muscles look striped or *striated* (STRY ay ted).

INVOLUNTARY MUSCLE

Involuntary muscles are muscles that you generally *cannot control*. Involuntary muscles form the walls of most of the digestive tract. They are also found in blood vessels and other internal organs.

Involuntary muscles look *smooth* under a microscope. For this reason, involuntary muscles are sometimes called *smooth* muscles.

CARDIAC MUSCLE

Cardiac muscle is *heart* muscle. Under a microscope, cardiac muscle appears *striated* like voluntary muscles. But, cardiac muscle is *involuntary*. You have no control over cardiac muscle.

THE HUMAN MUSCULAR SYSTEM

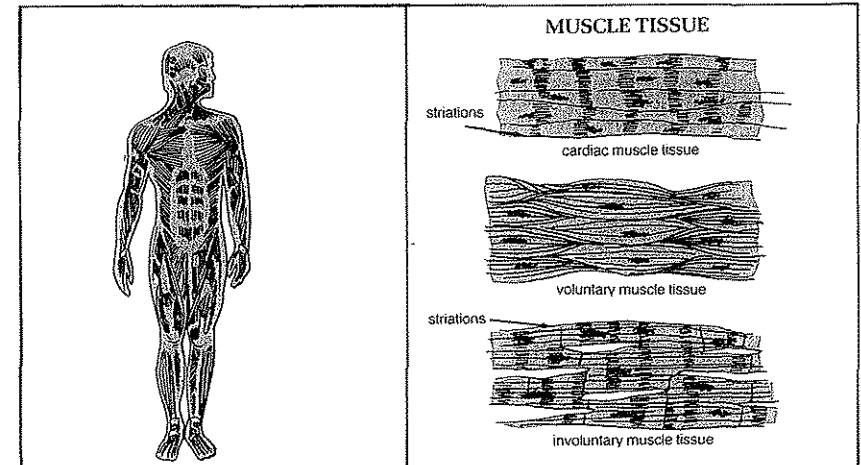


Figure A

Answer these questions about the human muscular system.

- About how many muscles does a person have? _____
- Name the three main types of muscle. _____, _____, _____
- Muscles that we control are called _____ muscles.
- Muscles we cannot control are called _____ muscles.
- “Cardiac” means _____.
- Cardiac muscle is _____
voluntary, involuntary
- Which kind of muscles are attached to bones? _____
voluntary, involuntary
- Under a microscope,
 - voluntary muscles and cardiac muscle look _____
smooth, striated
 - involuntary muscles look _____
smooth, striated
- What do muscles produce? _____
- Muscles produce movement by _____
pushing, pulling

MORE ABOUT MUSCLES

Skeletal muscles work in pairs. One muscle works in the opposite direction of the other.

For example:

- The controlled muscle pulls. This causes movement.
- While the controlled muscle pulls, the other muscle relaxes.

It must! Otherwise, there would be no movement.

Let's work with two actual examples. Study Figures B and C. Then answer the questions.

I. Figure B shows some of the muscles of the arm.

1. Name the paired muscles that bend the elbow. _____

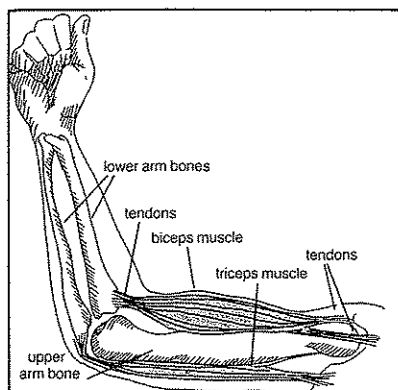


Figure B

Now, think carefully about these questions.

2. To bend the arm,

a) which muscle must contract? _____

b) which muscle must relax? _____

3. To straighten the arm,

a) which muscle must contract? _____

b) which muscle must relax? _____

4. Most voluntary muscles connect to bone by means of special "go-between" tissue.

What is the name of this tissue? _____

II. Figure C shows some of the muscles of the leg.

5. Write the common names of the muscles that move the leg.

6. To bend the leg,

a) which muscle must contract? _____

b) which muscle must relax? _____

7. To straighten the leg,

a) which muscle must contract? _____

b) which muscle must relax? _____

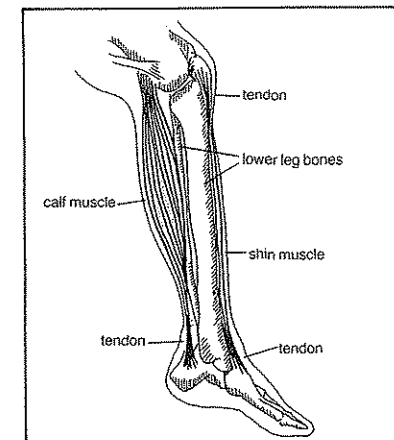


Figure C

SOME HEALTHY ADVICE

Muscles must be used often to be kept healthy. Regular, moderate exercise—and a good diet—help keep all your muscles in top shape. This includes your heart.



COMPLETING SENTENCES Complete the sentences with the words below

voluntary
striated
relaxes
tendons

bones
pull
muscles
contracts

push
smooth
involuntary
pairs

1. Body movements are caused by _____.
2. Muscles that you can control are called _____ muscles.
3. Muscles you cannot control are called _____ muscles.
4. Most voluntary muscles are connected to _____.
5. Muscles are connected to bones by _____.
6. Skeletal and _____ muscle look _____ under a microscope.
7. Under a microscope, involuntary muscles look _____.
8. Muscles can only _____; they cannot _____.
9. Voluntary muscles act in _____.
10. When one muscle _____, its opposite muscle _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-----------------------------|--|
| 1. _____ cardiac muscle | a) connects to bones |
| 2. _____ involuntary muscle | b) smooth muscle that you cannot control |
| 3. _____ voluntary muscle | c) striped |
| 4. _____ striated | d) heart muscle |
| 5. _____ tendons | e) connect skeletal muscle to bones |